Vol. 15 No. 11 November 1961 Published Monthly

INSTRUMENT PRACTICE

CONTROL SYSTEMS - ELECTRONICS - AUTOMATION

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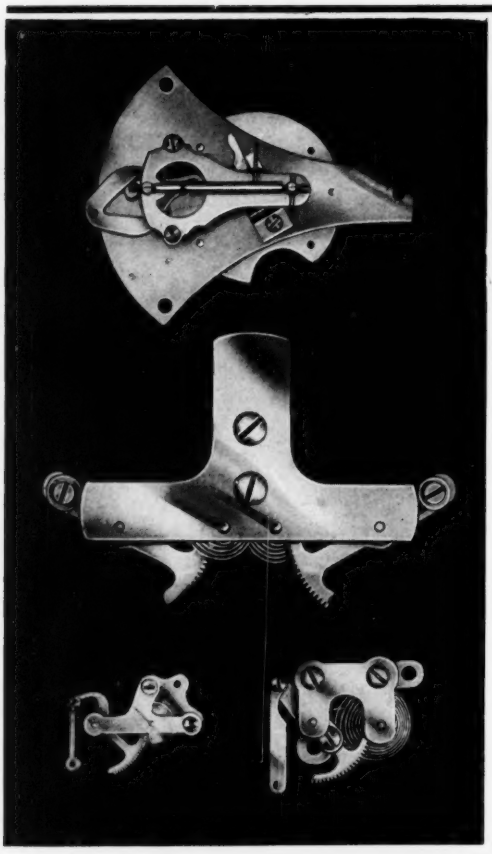

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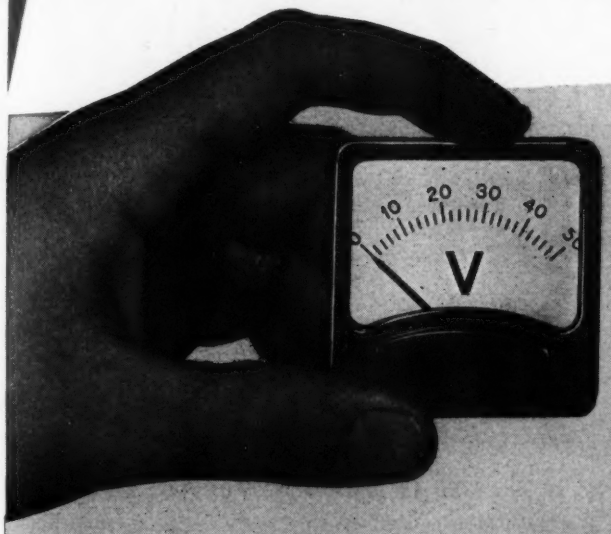

Above: 2" square moving coil voltmeter

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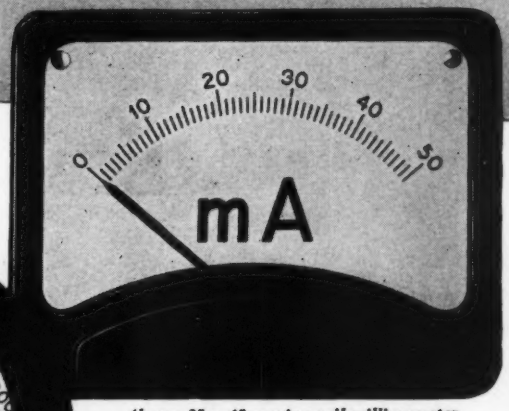
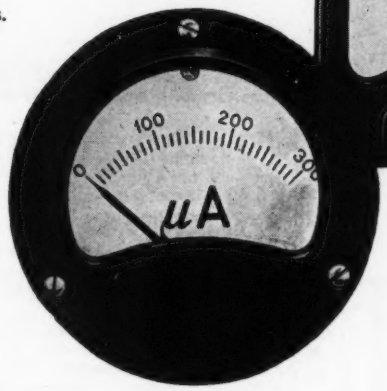


Above: 3" x 4" moving coil milliammeter



Left: 2½" round moving coil microammeter

SPECIFICATIONS B.S. 89–1954 and other international standard specifications, or B.S. 2011/H3 if required.

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Moving coil for D.C. applications.
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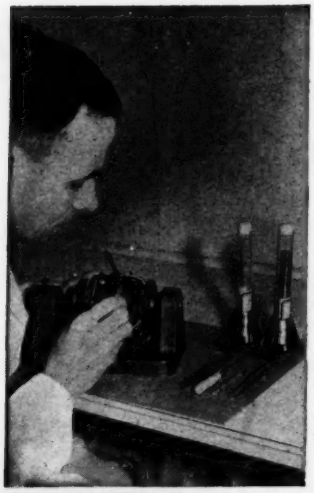

Assembling the Gyro Rotor for a C.L.2 Gyrosyn® Compass. Note the dustproof dispensers containing the bearings.

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HOFFMANN BEARINGS, fitted extensively to Sperry instruments, help them to function consistently and accurately to Sperry standards.

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Like many other well-known civil and military aircraft, the Handley Page Dart Herald Branch Liners ordered initially by B.E.A. and Jersey Airlines, rely extensively on Sperry equipment for automatic flight control and instrumentation, the latter including Gyro horizons and Gyrosyn® compasses employing Hoffmann Bearings. The trouble-free performance of these instruments was demonstrated in the most practical manner by the prototype and first production aircraft respectively in four recent demonstration tours to India, South America, Australasia and West Africa. Sperry Gyrosyn Compasses have, for many years, depended on Hoffmann Bearings for long life, accuracy and reliability.

35,000,000,000 REVS

The record of Port Line's M.V. Port Fairy, 8,406 tons, includes 65 round voyages between U.K. and New Zealand in 32 years, guided by a Sperry Mark VIII Gyro Compass. Since 1943 the 51 lb. weight of the compass rotor has spun steadily at 6,000 r.p.m. upon its HOFFMANN BEARINGS and to date has completed more than 35,000,000,000 revolutions. It is still spinning, trouble free, and accurate upon those same HOFFMANN BEARINGS.

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Illustrations by courtesy of Sperry, Handley Page, Port Line and P & O – Orient Lines.

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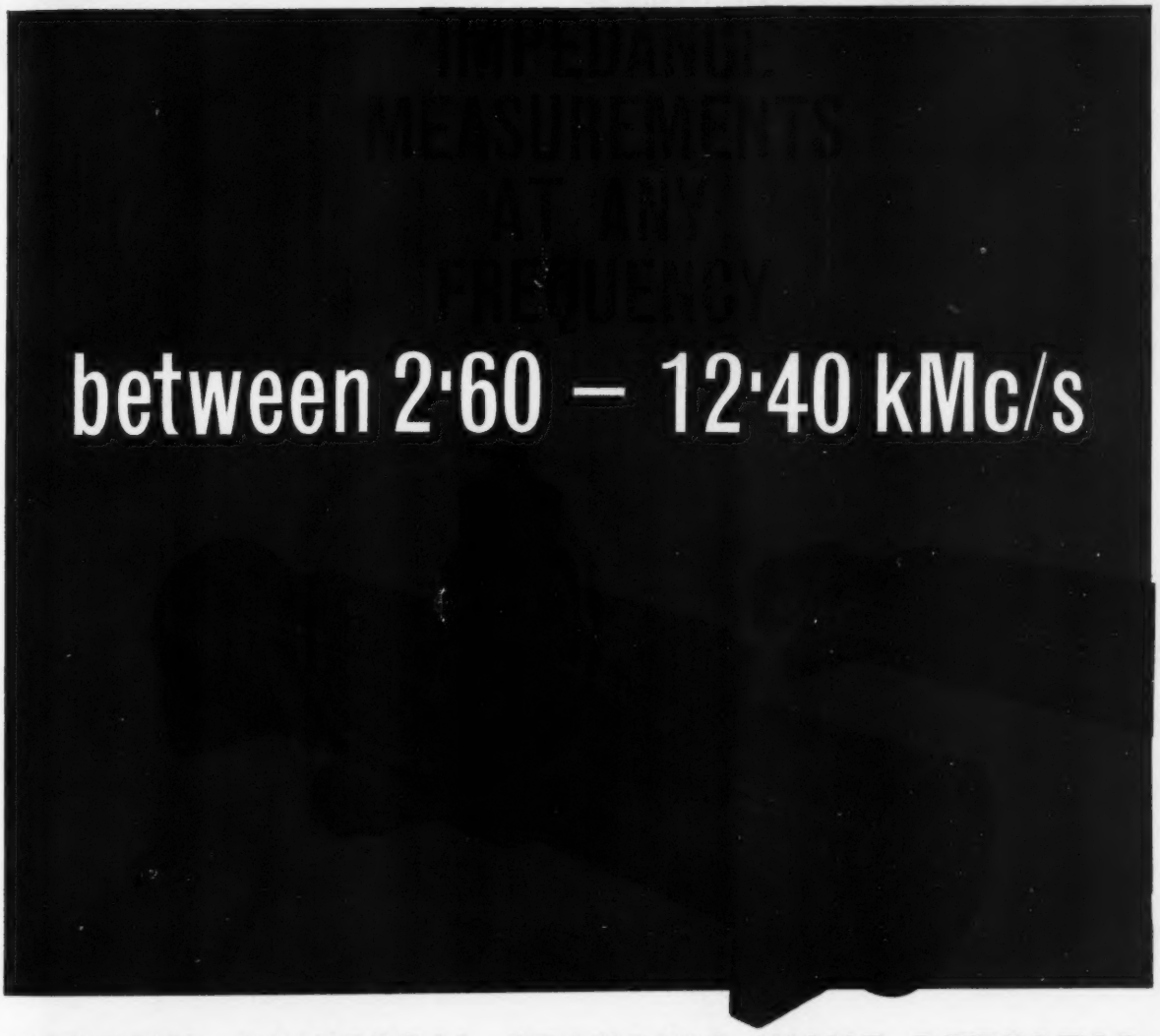

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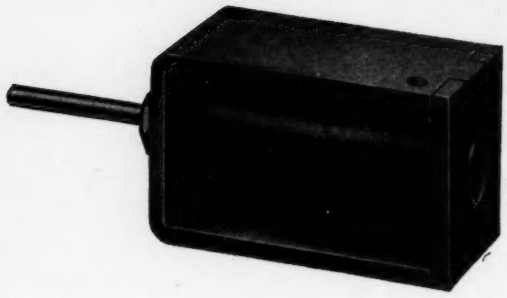

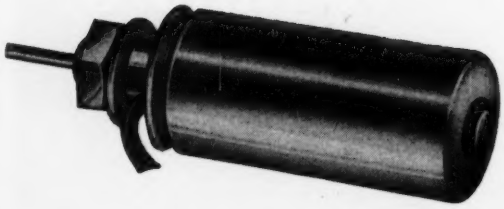

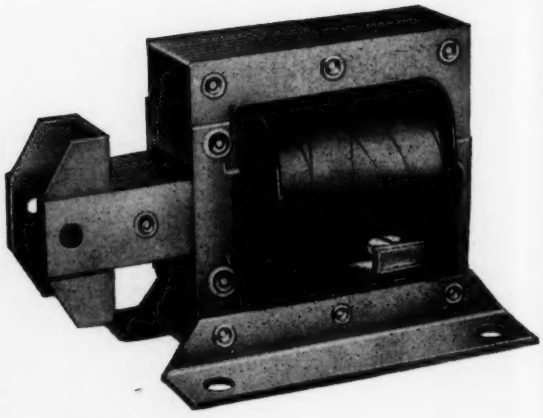

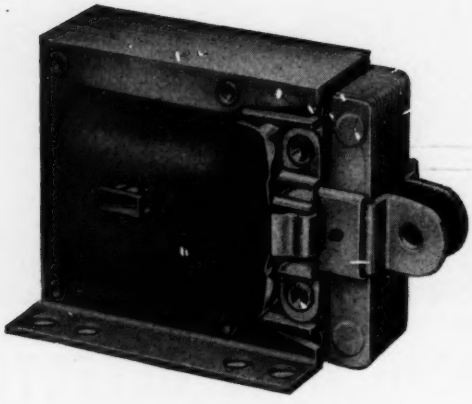

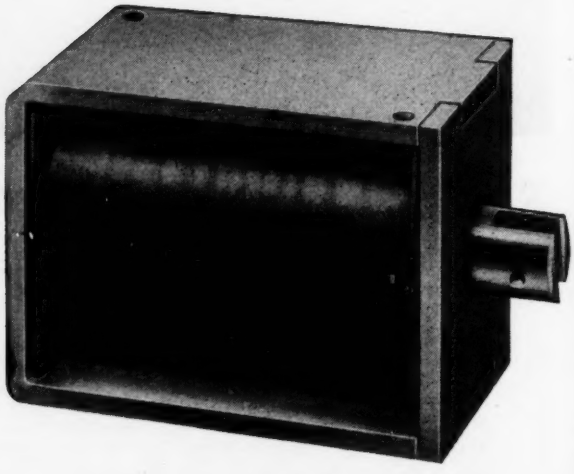

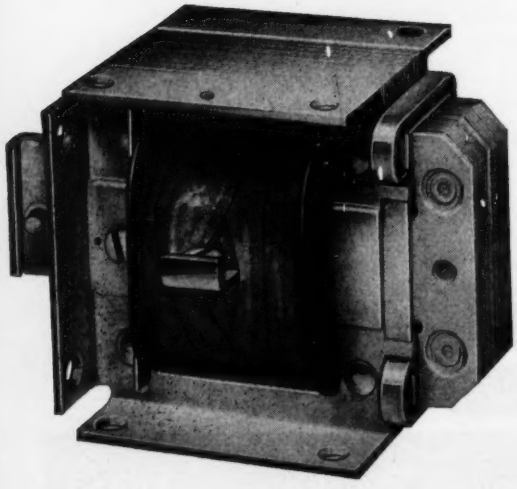

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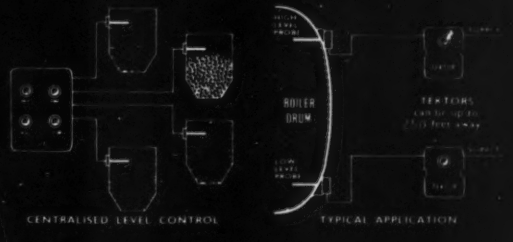

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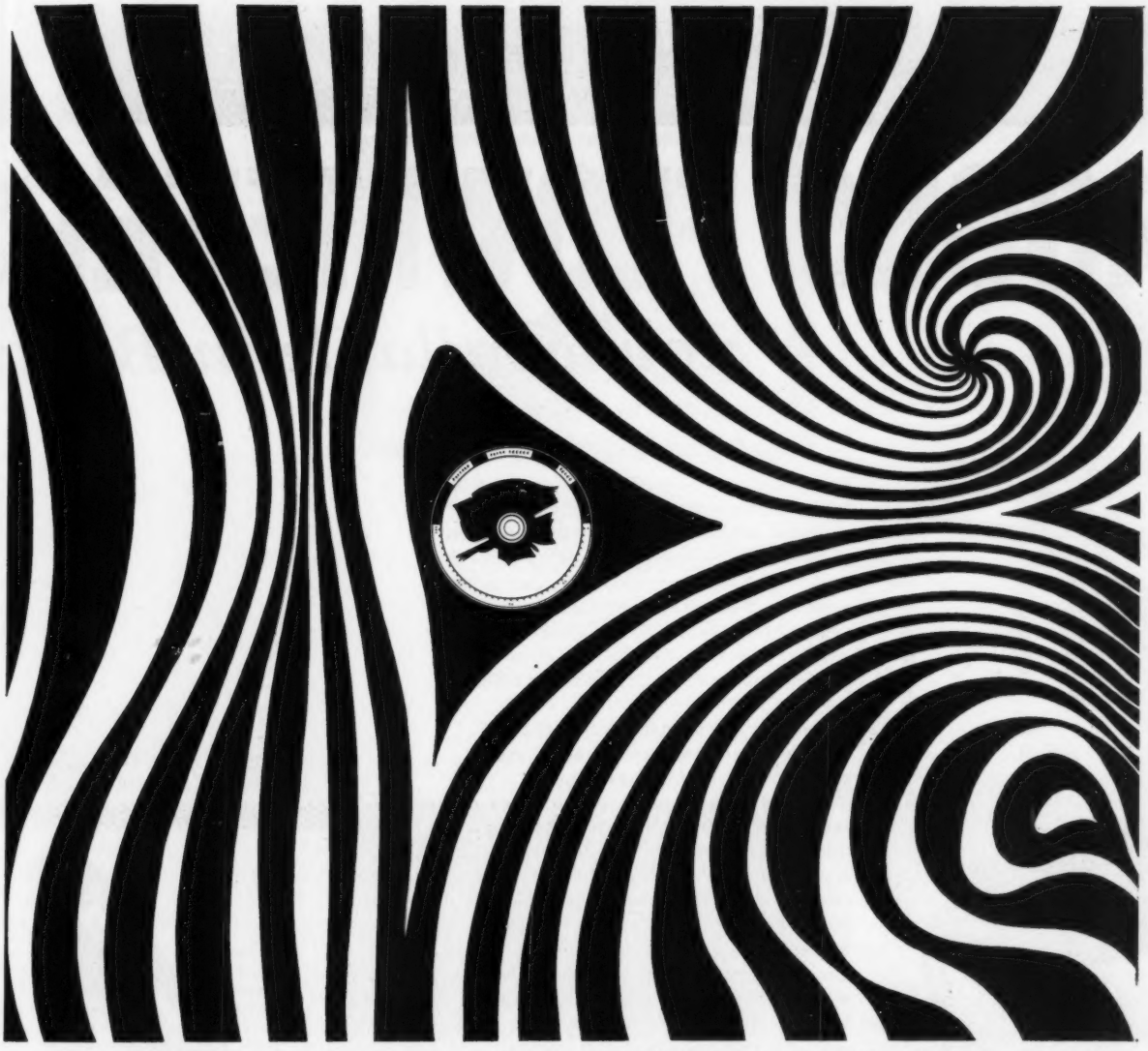

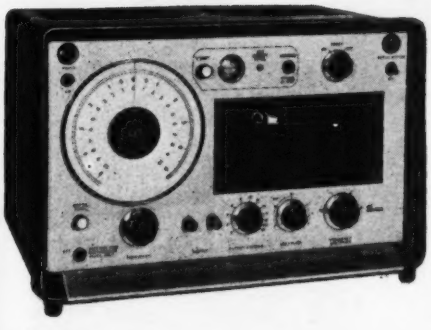

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A company whose management and staff have many years experience in the service of instrument technology.
Illustrated on these pages are just a few of the vast range of precision built and top-quality made Brooks flowmeters now available.
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DAVID Y. SMITH Managing Director, Brooks Instrument Ltd., Great Britain says "Our field representatives are already being increased to meet the demands of industry throughout Great Britain and Ireland—this will mean 'service-on-the-spot' soon for many manufacturers"

MODEL 1110

MODEL 2001V BROOKSM

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MODEL 1112

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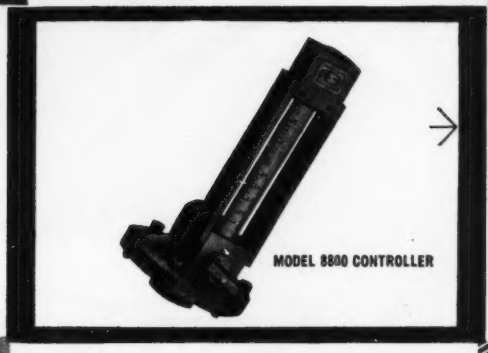

MODEL 8800 CONTROLLER

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The dual taper SHO-RATE 50 purge BROOKSMETER permits standardisation on a single model for a vast majority of purge applications.

MODEL M.P.T.X 50

The M.P.T.X 50 Brooksmeter is a thru-flow transmitter. It has no elbows, pockets or turns. Just a straight, clean, smoothly tapered metering tube and a float. Available with either pneumatic or electrical transmission. Both are compatible with most receivers and controllers.

MODEL SHO-RATE 150

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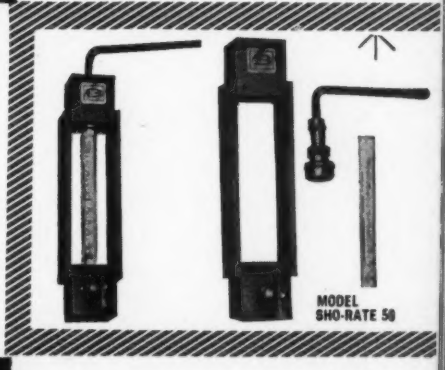

MODEL 1110

The full-view Brooksmeter is intended for general metering installations where the operating pressures are within the limitations imposed by the use of glass metering tubes. Dowel-pin, side-plate construction, detachable or direct-etched flow scales. Scale lengths 127 mm, 150 mm and 250 mm.

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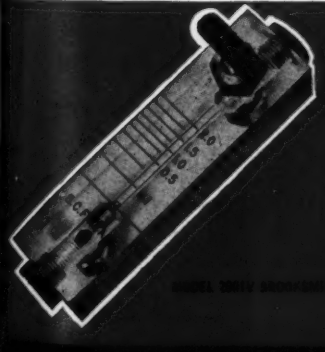

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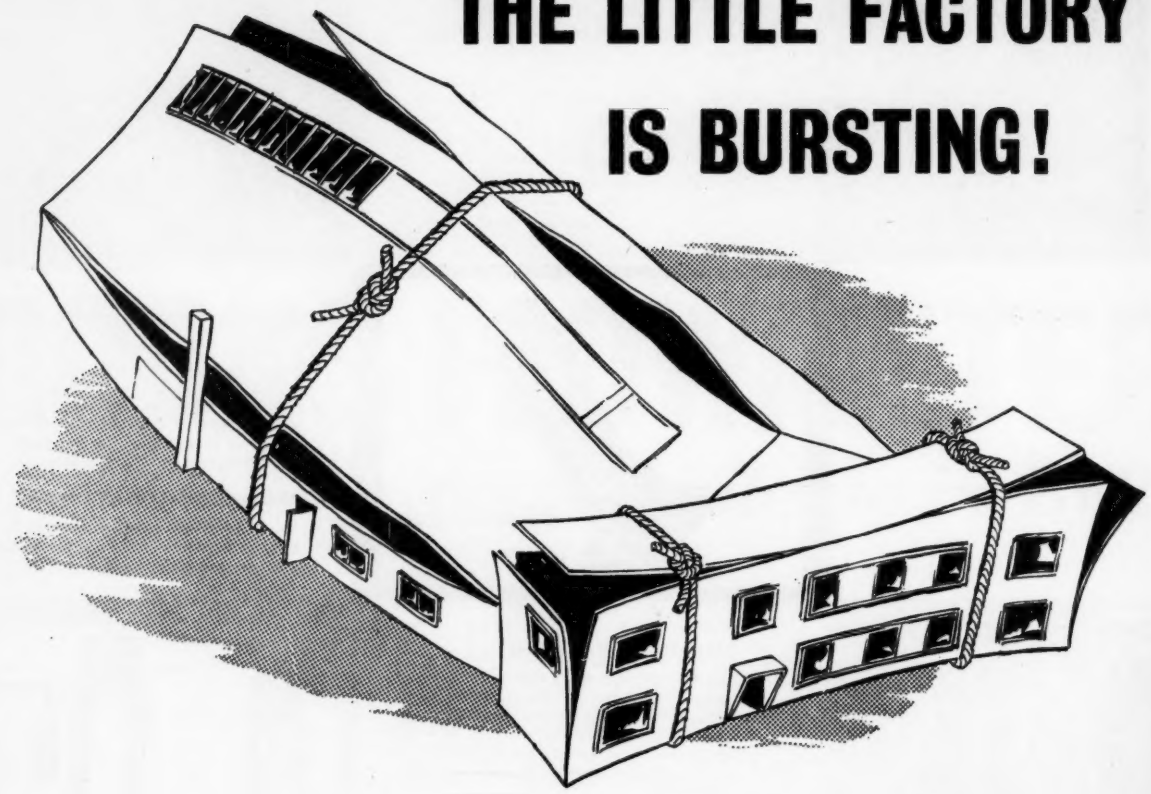
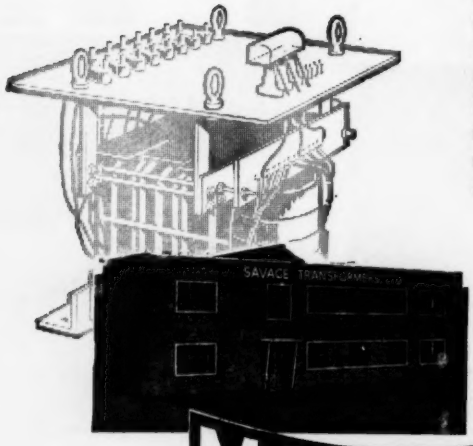


Little things and little places are endearing and have many advantages which are denied the giants. Our own enviable reputation, for example, has been due very largely to our staff who, realising that they are part of a small team of experts, have given of their best. Business, however, does not stand still. The reputation has resulted in more and more orders and we are "bursting at the seams". Production space at the little factory is therefore being doubled and we will soon be able to give on a larger output the quick and definite deliveries synonymous with Savage Transformers Limited.



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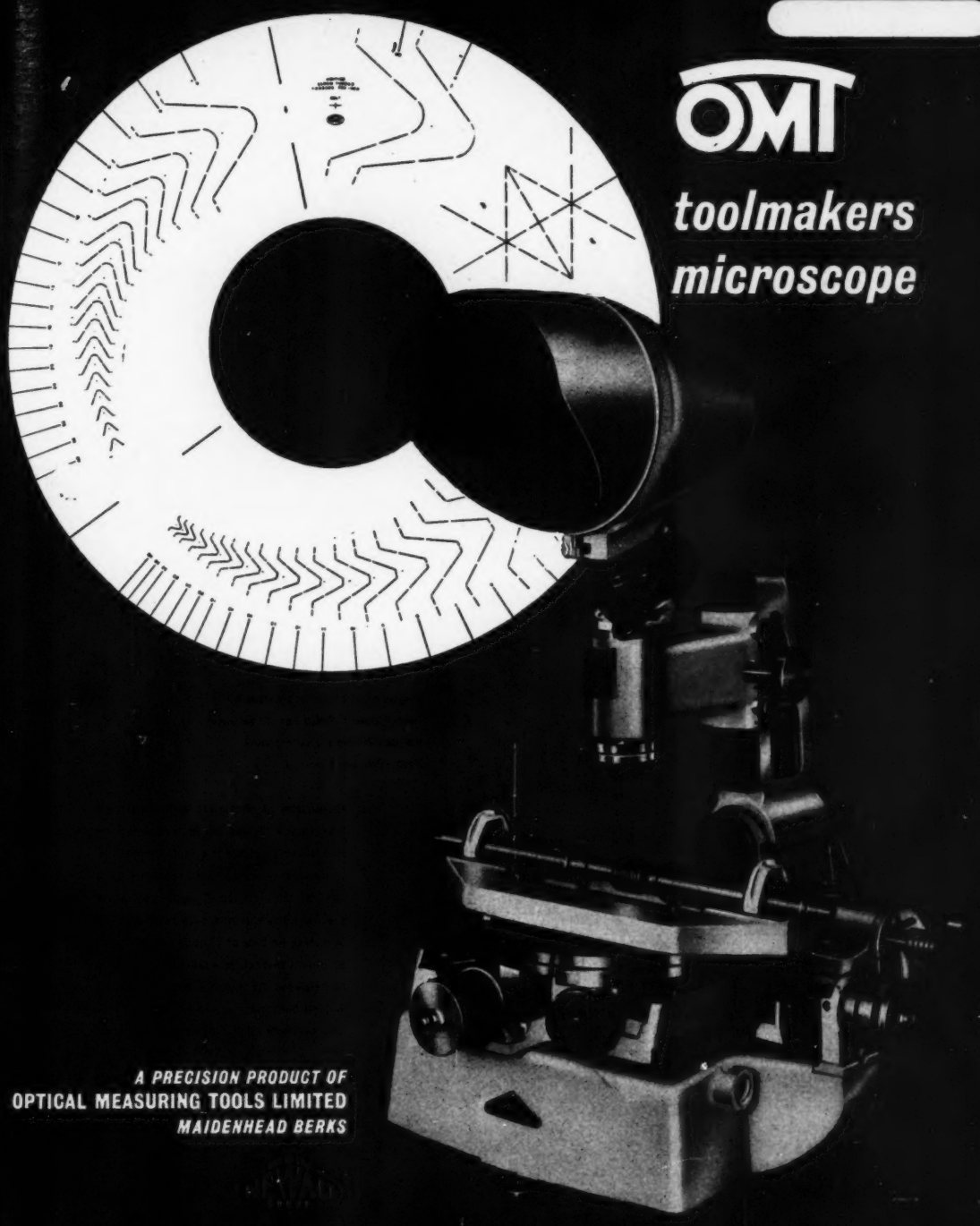

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A WORLD OF VIBRATION

Vibration technology is a comparatively new development in the field of environmental engineering. Its applications in measuring metallurgical stresses and strains, in simulating fatigue to destruction point, are fairly well-known, but even the present scope is far wider than these. The potential is immense to a degree which possibly outreaches that of any other applied science. It is even possible that there is much to be rediscovered, for the histories and mythologies of ancient civilizations abound in references to physical motion achieved through sound vibrations. The destruction of the walls of Jericho is an example; and it has been suggested that the Pyramids' vast masonry was elevated by similar means. But fascinating and perhaps revealing as that line of inquiry may be, this report will deal principally with the immediately practical uses of vibration testing.

From eyes to motor cars is an apt and related part of the applications range. Taking the first and uncomfortably picturesque example, an incidence of severe headaches and impaired vision suffered by transport drivers led to tests with vibration equipment. These showed that through vibration on certain road surfaces, the drivers' eyes were being literally bounced back and forth in their sockets.

MOTOR VEHICLE INDUSTRY

Car bodies and their attachments are subject to mechanical and other vibrations transmitted through suspension systems. What with wear and tear and varying concern for maintenance, the noises which can result are an age-old problem at the service station. The drumming heard by the owner 'under the back seat somewhere' is usually non-existent in normal workshop testing; out on the road it's audible but locating it is a tedious and uneconomic guessing game.

Yet further complications arise out of the fact that the vibration source may be far removed from the apparently offending component or structure.

We have a compact generator/oscillator/power amplifier combination by which all the running vibrations can be simulated *in the workshop* and the noise source accurately and quickly located. Similar equipment is used by car manufacturers so that vibrations can be compensated or designed out.

ROAD CONSTRUCTION

Roads, too, can be investigated with vibration equipment. An applied vibration is picked up at a distance, on an oscilloscope. The signal time and strength factors vary according to the nature and thickness of the surface and subgrade materials. By these readings it can be determined whether or not the construction is according to specification. Periodic tests will reveal the extent of any deterioration. In research, the behaviour of roads under various traffic conditions can be established and the information used in framing specifications for new roadworks.

AIRCRAFT INDUSTRY

In the aircraft industry, vibration testing has long been a vitally important technique. Bearing in mind the possible outcome of the failure of quite small components, vibration problems in land vehicles and structures pale into comparative insignificance. Goodmans equipment is widely used to test dynamic models . . . even whole aircraft . . . and on the multiplicity of instruments and electronic apparatus.

The tremendous power and complexity of rocket-propelled vehicles set still more exacting requirements and for these Goodmans are producing special generators.

OTHER APPLICATIONS

The miscellany of these is far too extensive to catalogue here, but the following will serve to demonstrate the scope.

In fatigue testing, vibration generators provide wide range and prolonged consistency.

Chemical and bio-chemical research are served by our smallest generator, the V47, in mixing, emulsifying and the measurement of interface potentials. It has been used also to simulate nerve signals and to assess vibration effect on living tissue. Experiments show that physical vibration and 'white noise' have anaesthetic properties.

Vibration equipment is used in the rubber, plastic and textile industries, as an aid in establishing the materials' mechanical properties.

Experiments in the machine tool industry have shown that small and carefully controlled vibrations can, in fact, improve stock removal, surface finish and minimize the effect of certain operations upon molecular structure.

This is inherently a world of movement. Everything vibrates within itself and often as an entity. These forces can be observed, reproduced, supplemented. There must therefore be many functions for our vibration equipment which even we can only guess at . . . and even more as yet unthought of. Name your problem; consider what may be done better, faster, more economically . . . what may be done perhaps for the first time, with the help of vibration equipment. It's more than likely that the means to the end is ready-made.

Goodmans electro-mechanical vibration generators, the largest range in Europe, comprise:

TYPE	PEAK THRUST
V47	2 lb
390A	17 lb
790	35 lb
8/600 Mk.II	300 lb
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There is available a corresponding range of oscillators and power amplifiers

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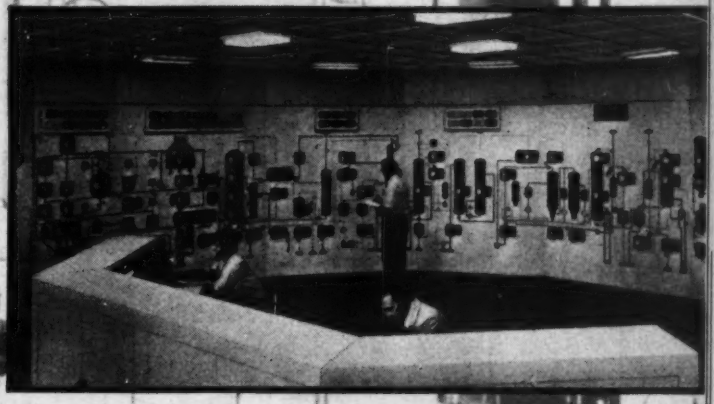

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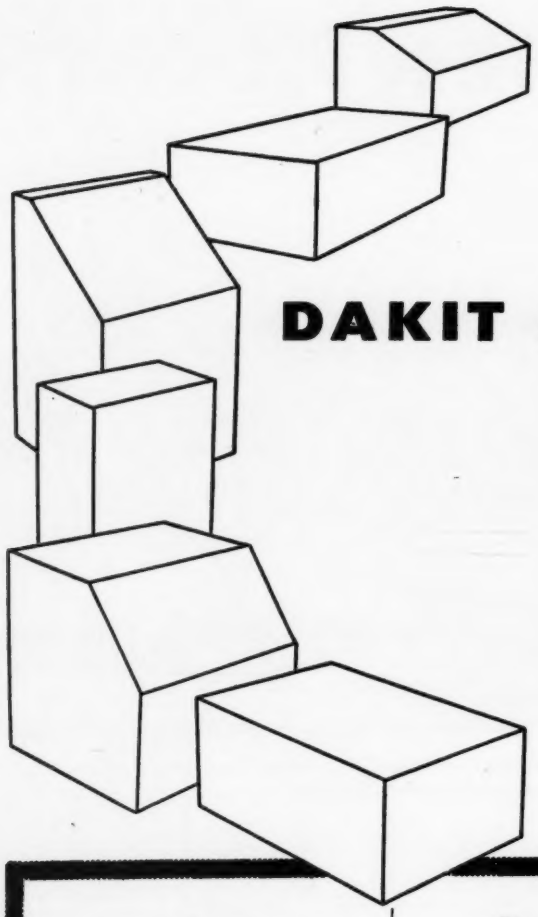

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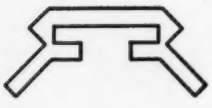

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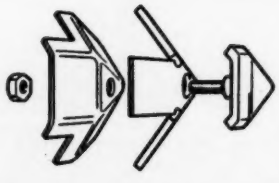
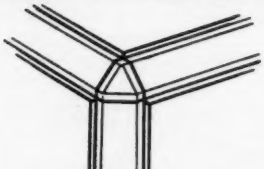


Single nut fixing for quick construction.



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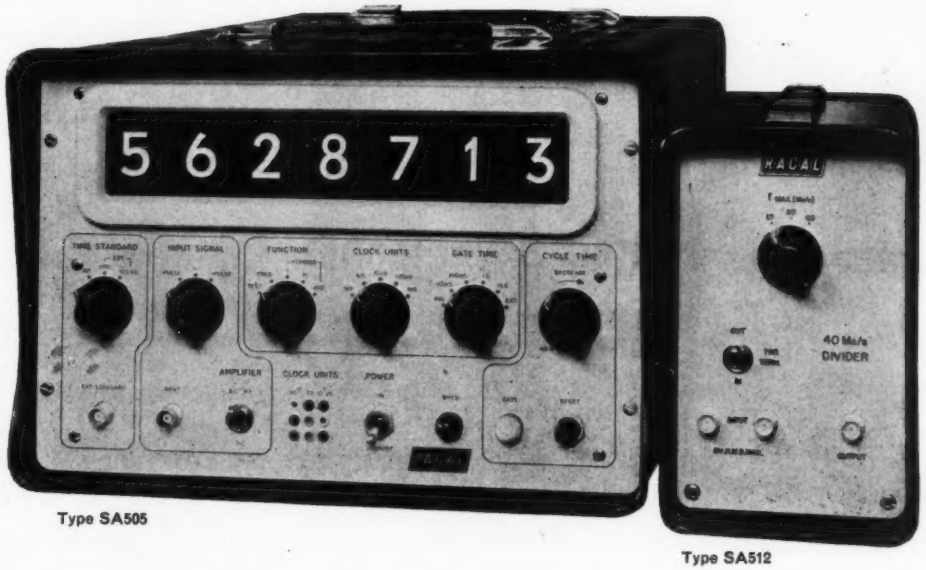

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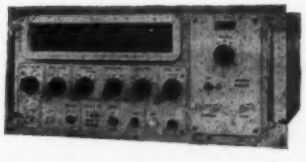

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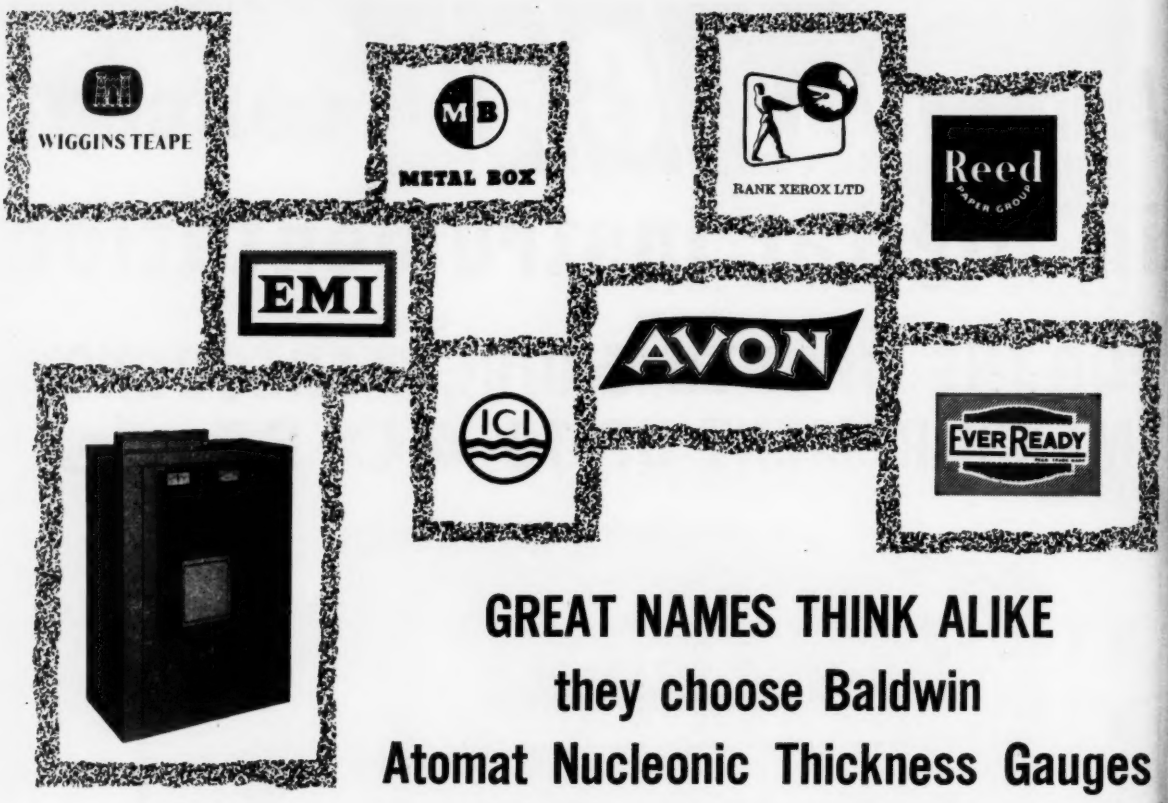

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...Yes, indeed, a nuclear precedent for industry

The photograph shows a close-up of one of the seal glands on the pressure vessel wall and biological shield at Berkeley Power Station through which pass some of the 982 "Pyrotenax" thermocouple cables. It is printed by courtesy of A.E.I.—John Thompson Nuclear Energy Company Limited, a Partner Company of The Nuclear Power Group.

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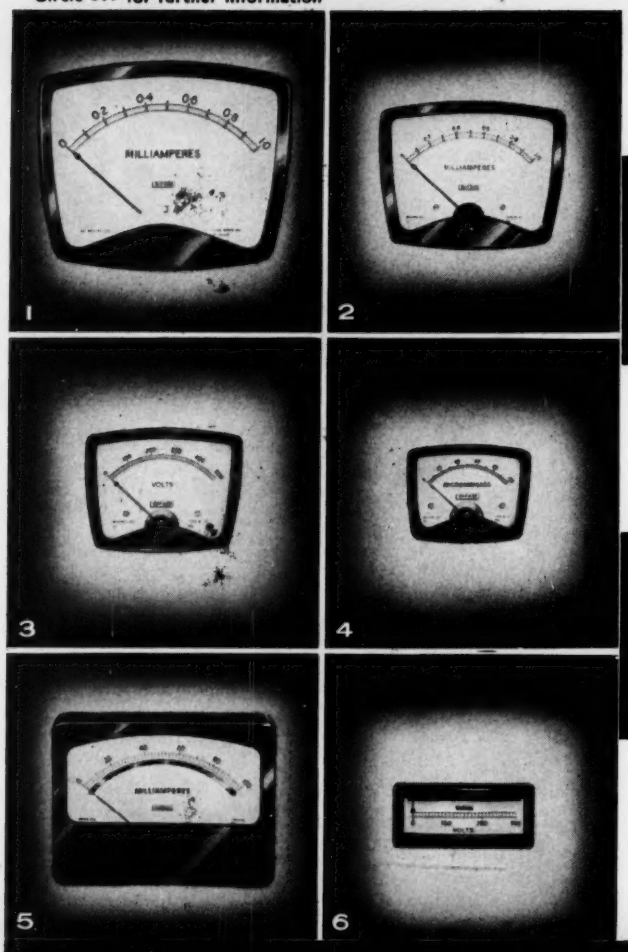

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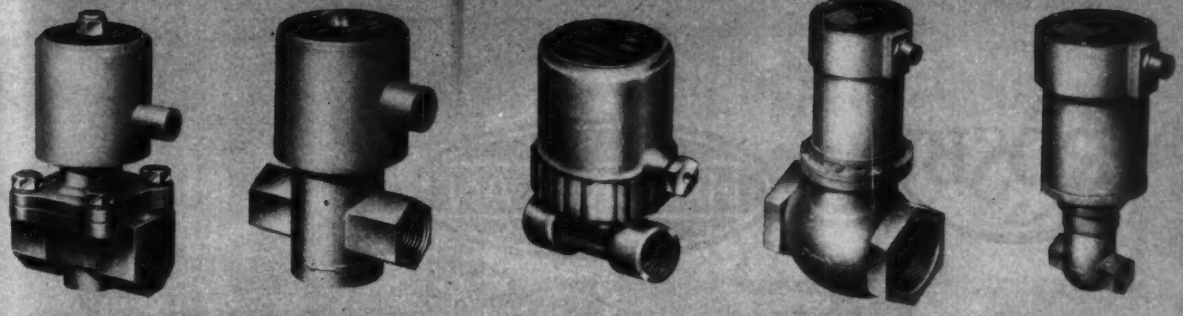

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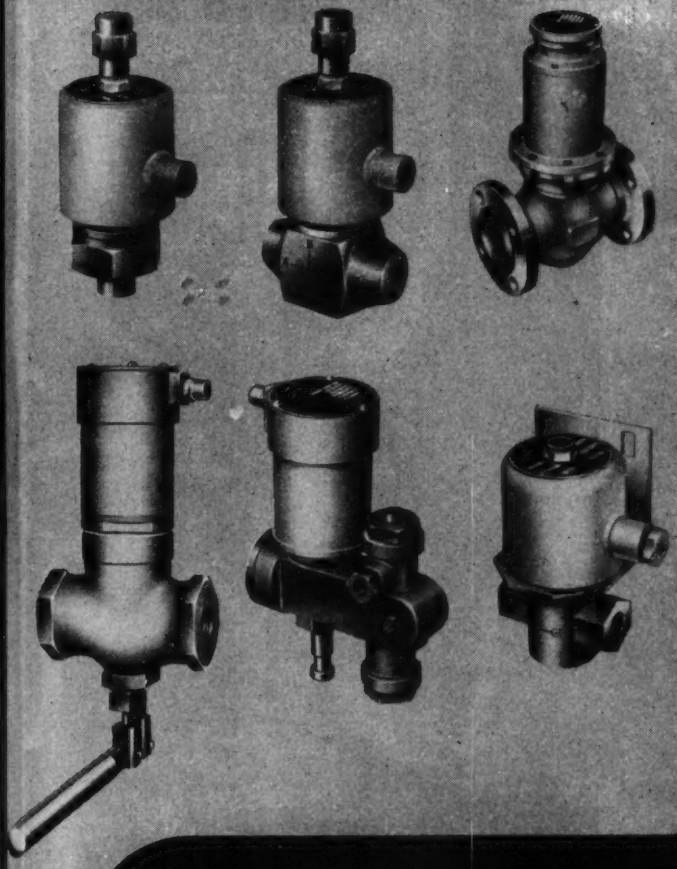

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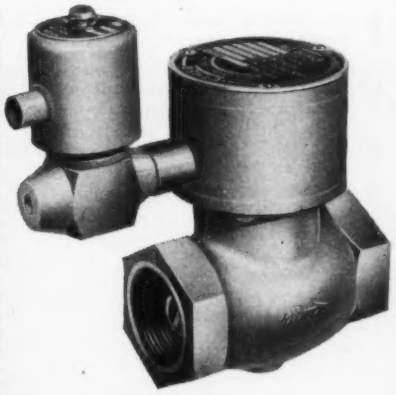

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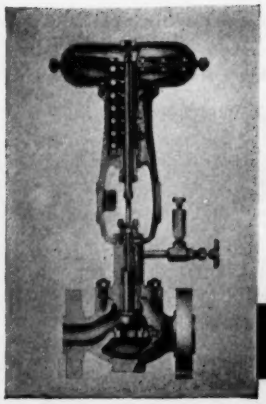

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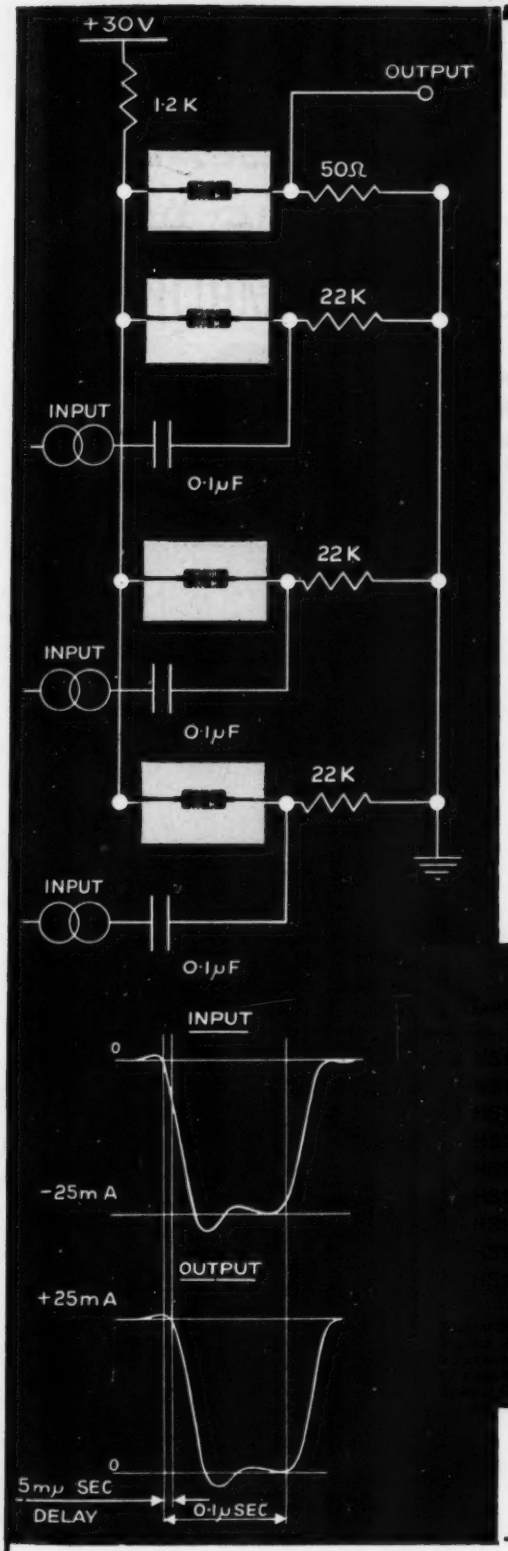

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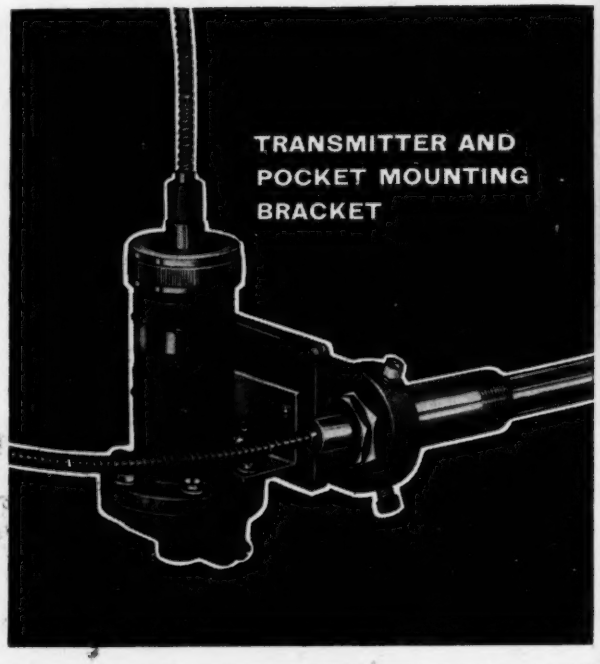

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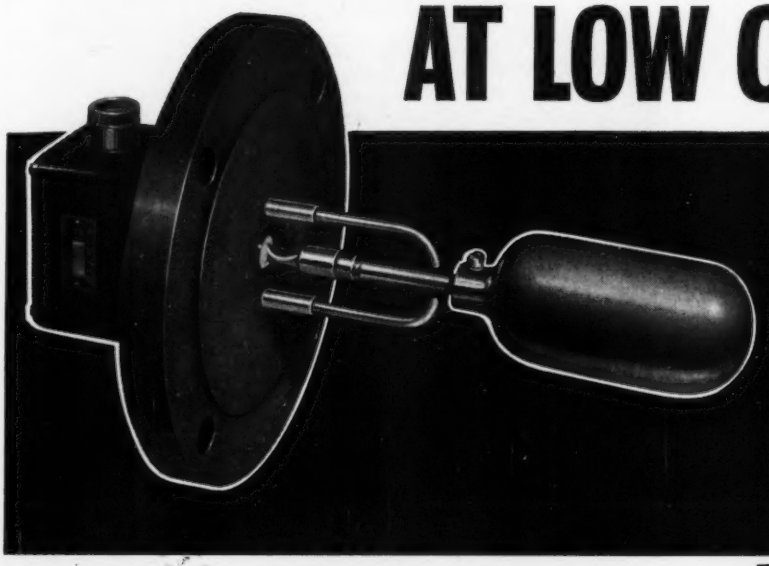

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TYPE 630

. . . designed for measuring phase difference between two signal sources in the range 1c/s to 10kc/s.

- ★ All transistor operation
- ★ Direct reading
- ★ Wide variations of signal amplitude permissible
- ★ High input impedance
- ★ High sensitivity
- ★ Self-contained batteries and mains power unit
- ★ No warm up period required
- ★ Extremely compact and portable
- ★ Very low power consumption

APPLICATION:

The Type 630 Transistor Phase Meter is an instrument designed to measure the difference in phase angle between two signals in the audio or sub-audio frequency range. It combines simplicity, low cost and adequate accuracy for almost all applications. Measurement of phase shift through networks, tuned circuits and servo systems may be readily made with negligible loading on the equipment under test. The instrument is particularly suitable for vibration and resonance testing and with appropriate pick-ups, measurement of torsional strain in rotating shafts can be made.

A simple phase meter such as the Type 630 is a valuable aid for the practical demonstration of circuit theory, feed-back, mechanical and electrical resonance and similar problems in Universities and Technical Colleges.

To prevent difficulty of interpretation when the signals are almost in phase, a 180° phase shift circuit may be selected and the 180°-0°-180° scale used.

The instrument uses readily obtainable torch batteries with a typical life of 40 hours at 8 hours per day. Alternatively operation from the normal a.c. mains supply is provided by the internal power unit.

Phase Angle Ranges:
0° — 360° or 180° — 0° — 180°

Frequency Range:
1 c/s to 25 kc/s

Input Voltage and Impedance:
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0.3 V to 3 V r.m.s. into 100k Ω
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Phase Accuracy:
With Balanced Signals 0° — 360° range
10 c/s to 10 kc/s ± 3°
1 c/s to 10 c/s ± 5°

180° — 0° — 180° range:
10 c/s to 10 kc/s ± 5°
10 kc/s to 25 kc/s—typically ± 5°
up to ± 10° phase difference.
With Unbalanced Signals typical error ± 10° for 3 : 1 or 1 : 3 unbalance from 10 c/s to 1 kc/s.

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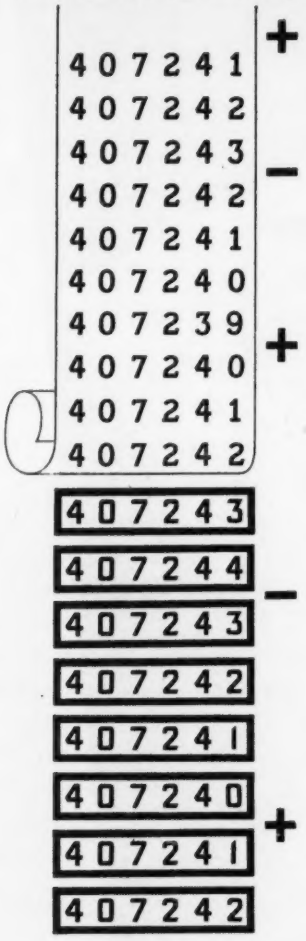

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PLUS *the transistorized chopper*

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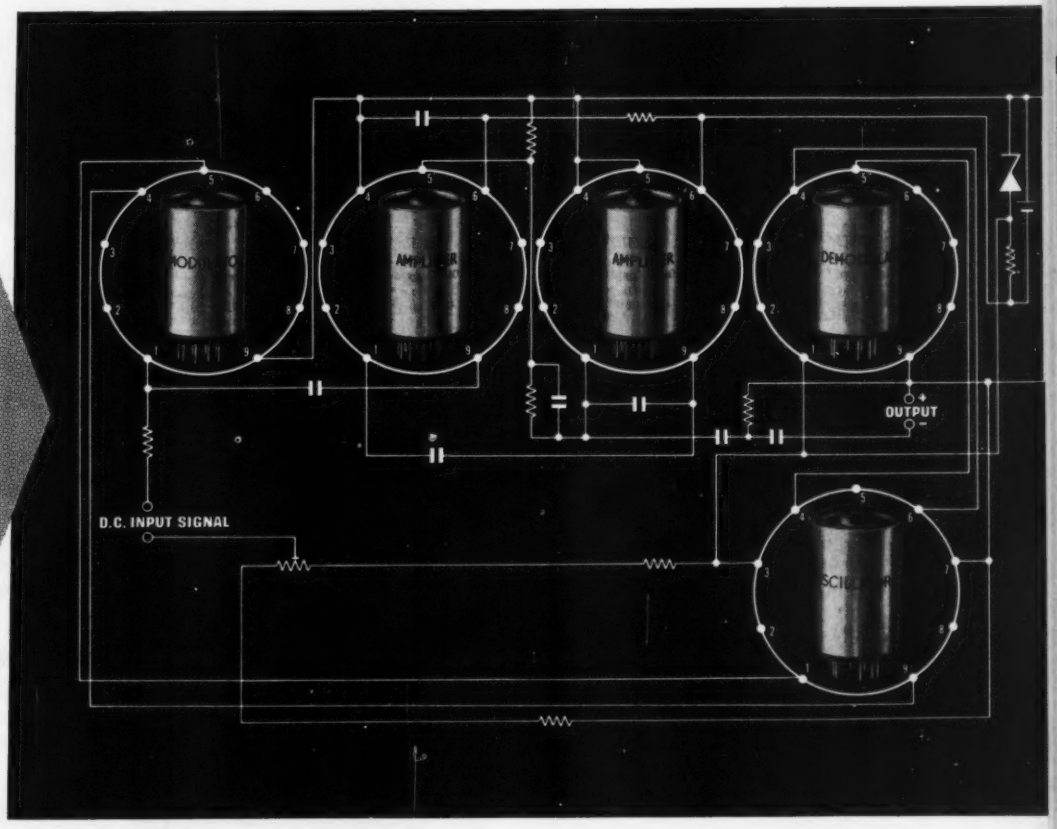

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s the Electronic Modulator SM10 recently launched by TMC - the first lly encapsulated transistorized chopper to be produced and sold in antity in Gt. Britain. Briefly, it is a highly stable, long life, fully encap- lated chopper. Its noise level is so low that it can actually chop a icrovolt signal. Chopping speed up to 1000 c/s.

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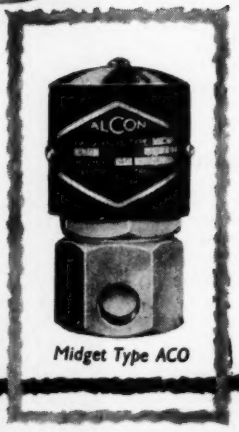
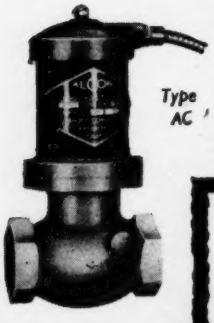
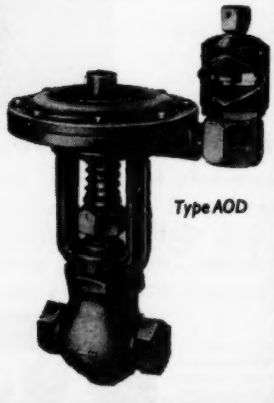


Midget Type ACO



Type AC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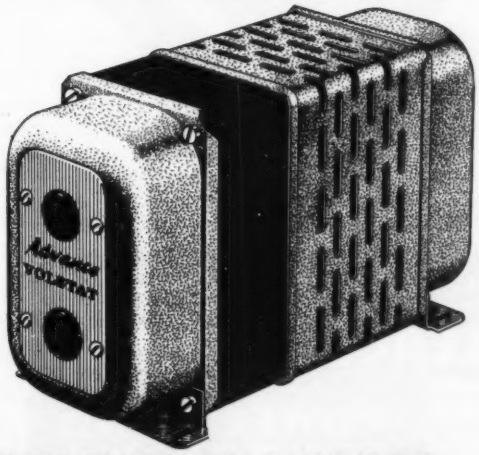

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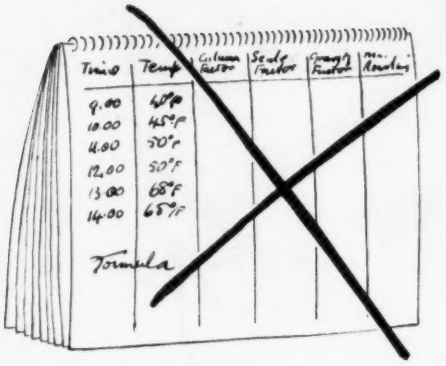

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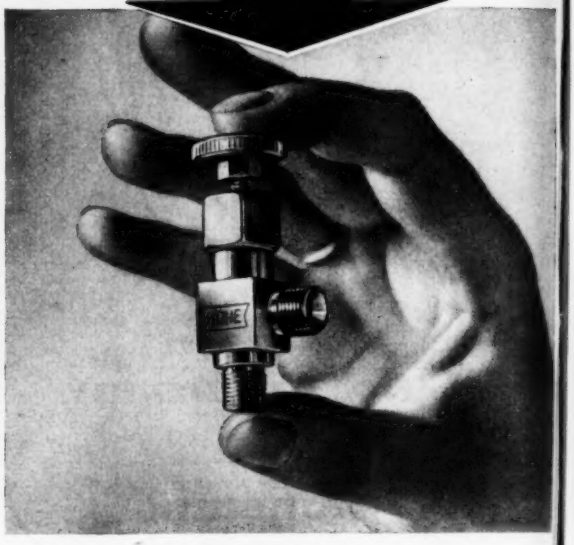

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700 1300
1200
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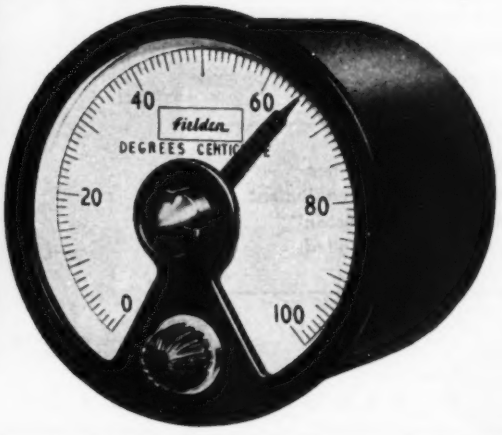

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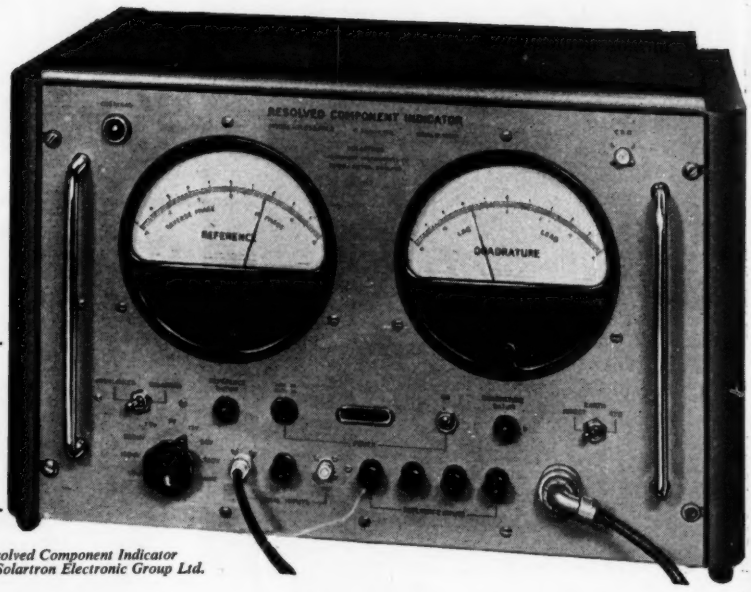

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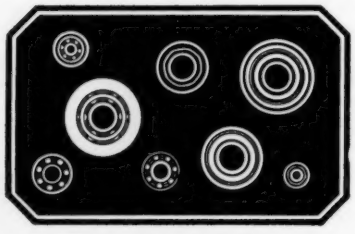

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13

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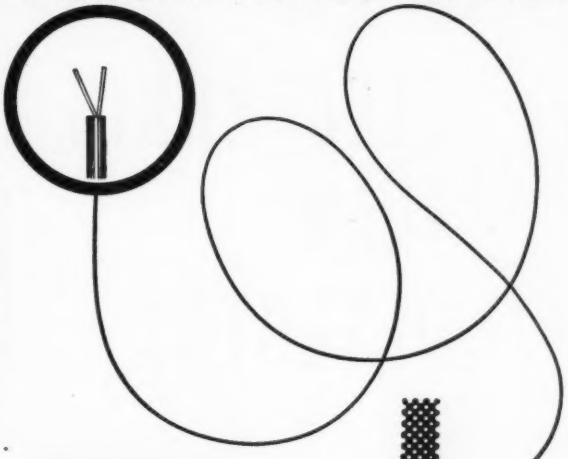

* *Marque deposee, produce of France* † *Trade mark Hoskins M/g. Co.*

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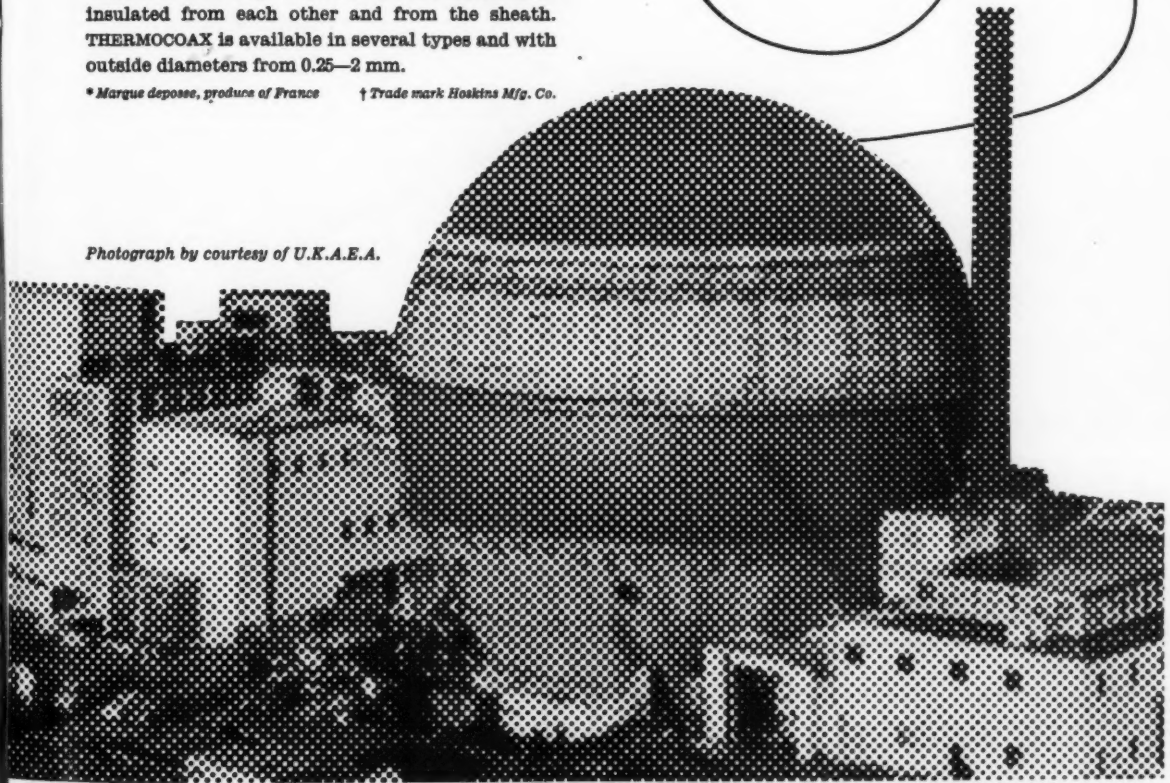

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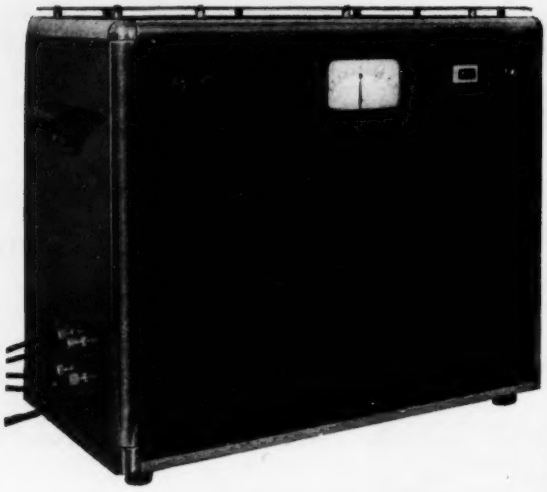

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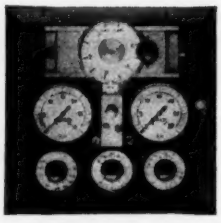

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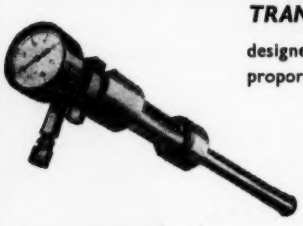
designed as a receiver for use with pneumatic transmitters, is of the non-indicating type with desired value scale calibrated in appropriate units.



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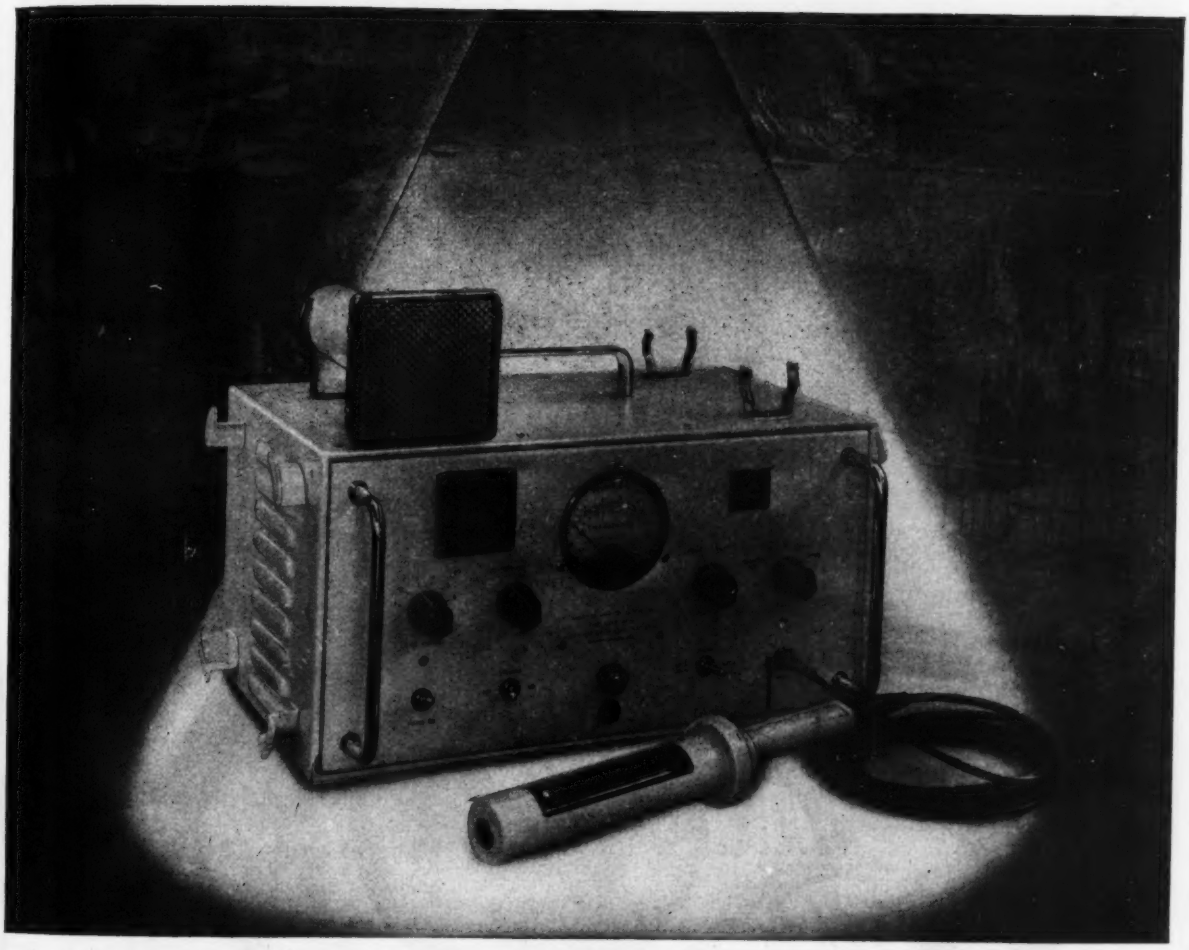

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Temp. °C.	Millivolts.
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50	2.02
150	6.66
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250	11.9
300	14.7
327	16.2
350	17.6

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The principal properties of TELCONSTAN are:—

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TELCONSTAN FOIL For Printed Circuits, Strain Gauges and other applications.

Thickness	Width	Weight in lbs. per 100 ft.
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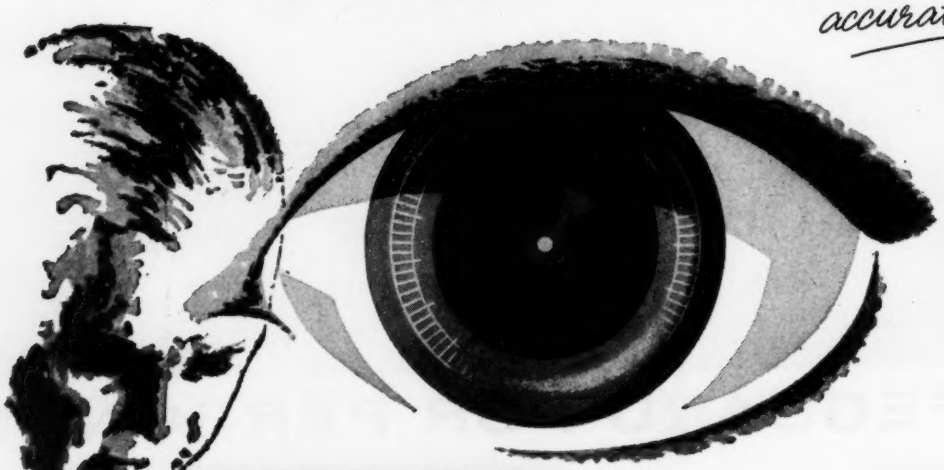

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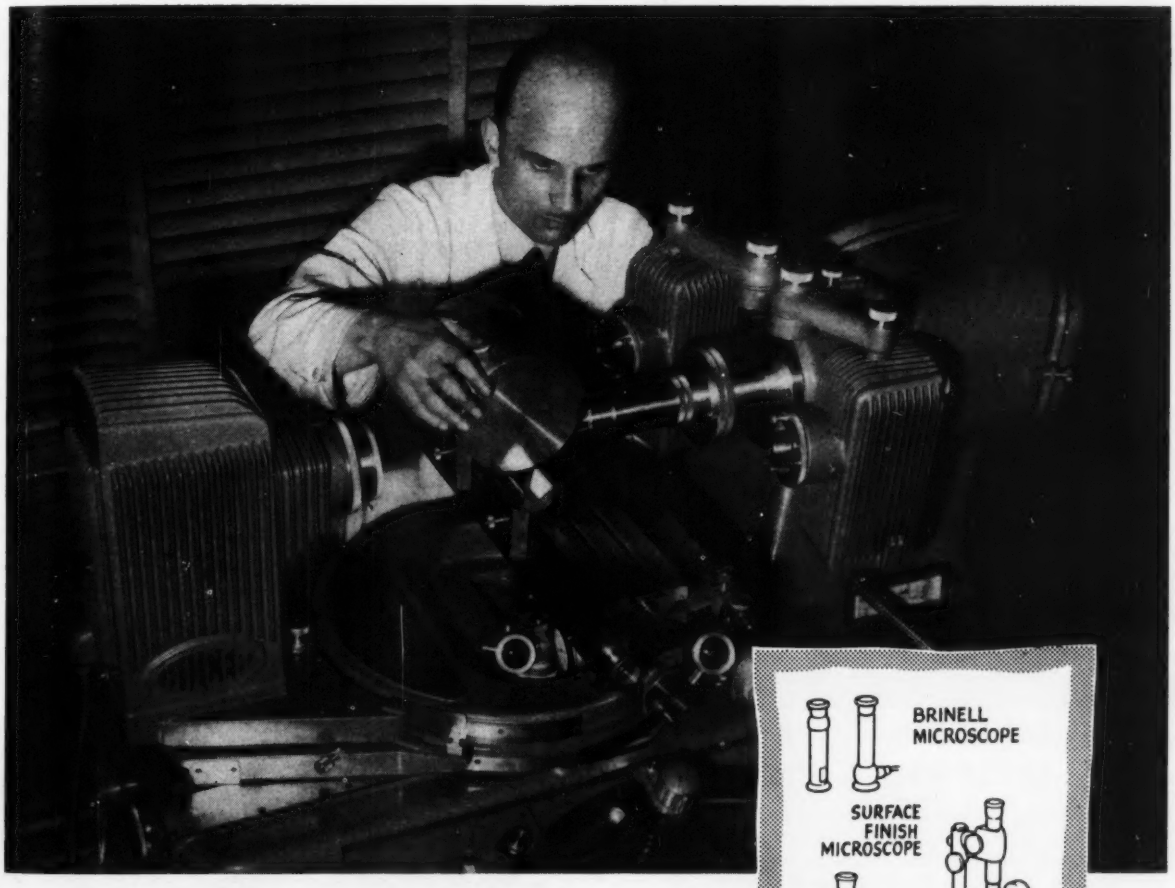

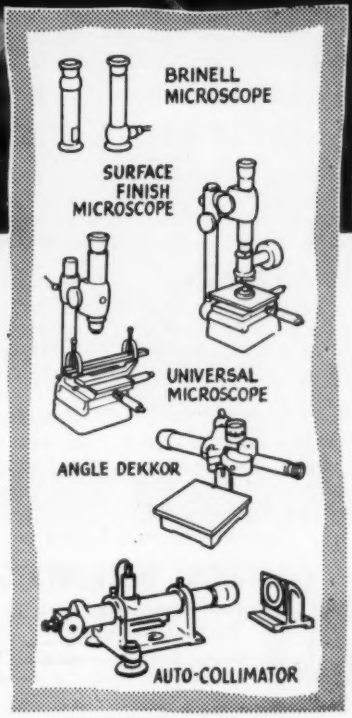

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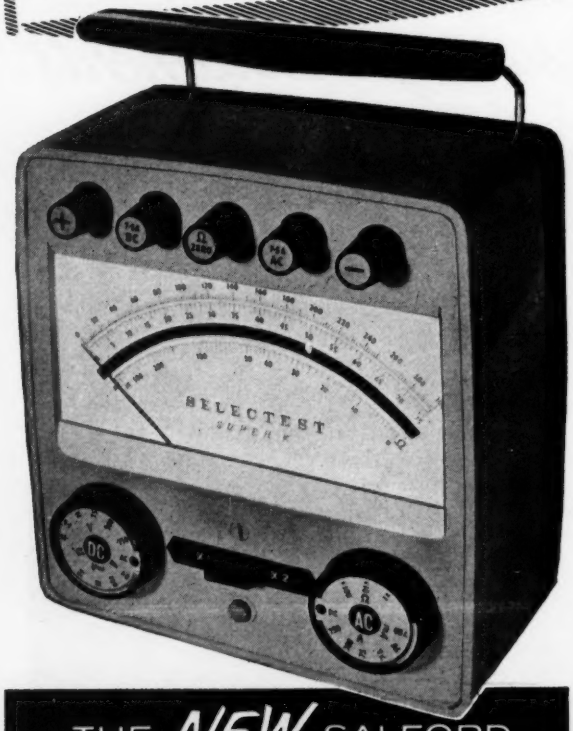

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A.C. Amps — 75mA to 15 A	

RANGES — Super 50	***Resistance***
D.C. Volts — 250mV to 2,500 V	0 — 2000 ohms
D.C. Amps — 50μA to 10A	0 — 200,000 ohms
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The internal magnet system was developed originally about 30 years ago but it is only in recent years that this method has been used on a large scale. The basic principle is simple; instead of a coil working around an iron concentrator in the pole tunnel of a large magnet assembly, the concentrator is replaced by a cylindrical magnet with iron pole shoes attached to give a linear distribution of flux. The coil then swings between the magnet assembly and an outer iron ring, which provides the return circuit and a shield against stray fields.

Usually, the pole shoes are either fixed by an adhesive or by solder or are dovetailed into the periphery of the magnet. All these methods however, introduce gaps of high reluctance in the circuit and difficulties can also arise in attaching the shoes accurately and firmly in position.

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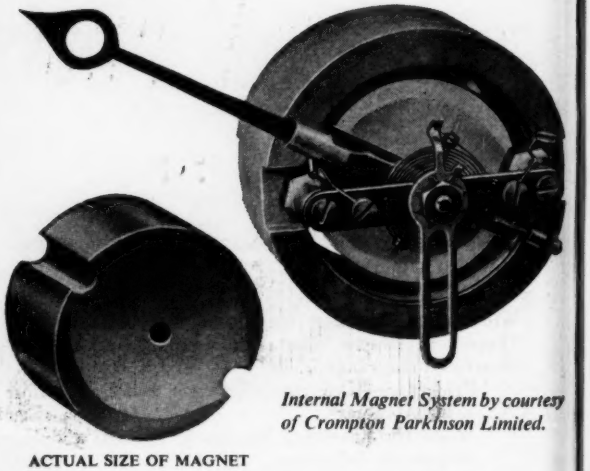

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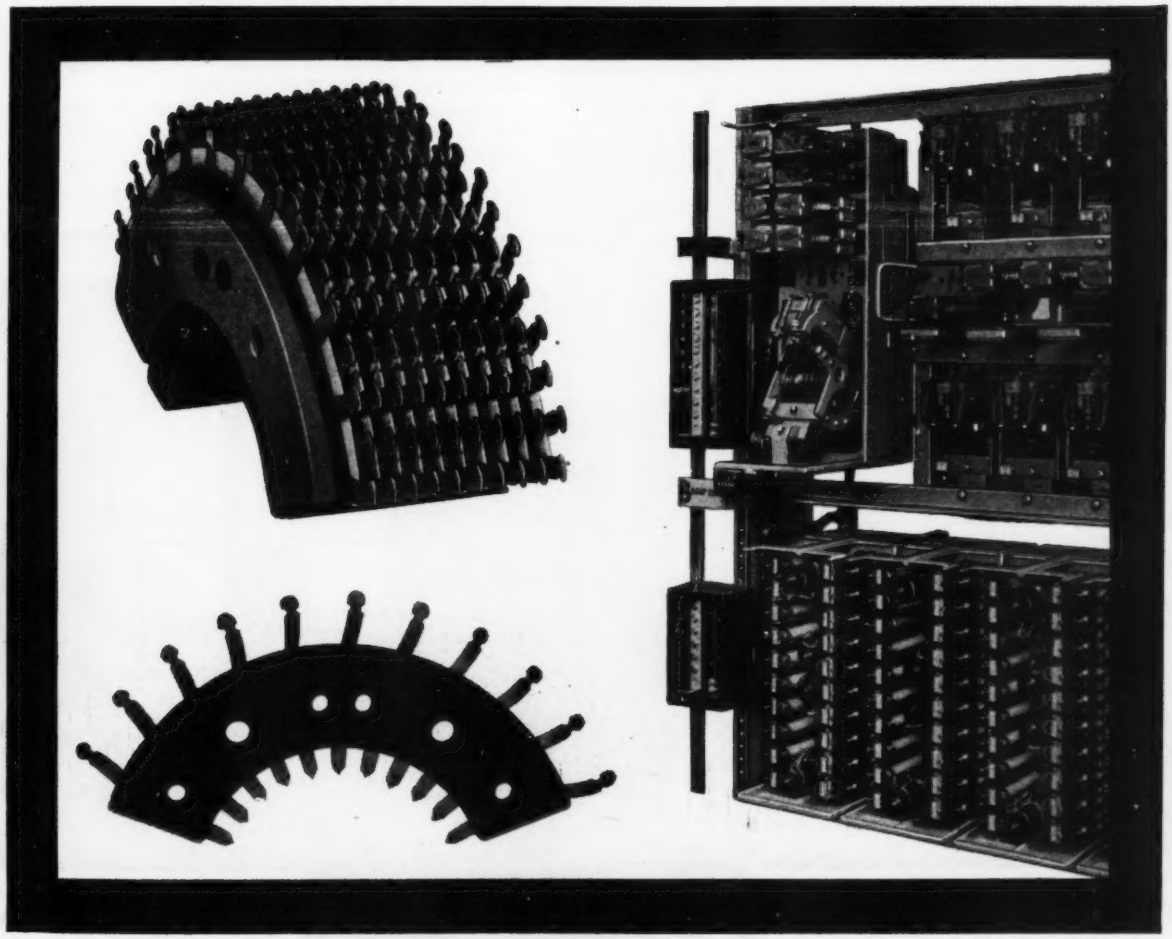

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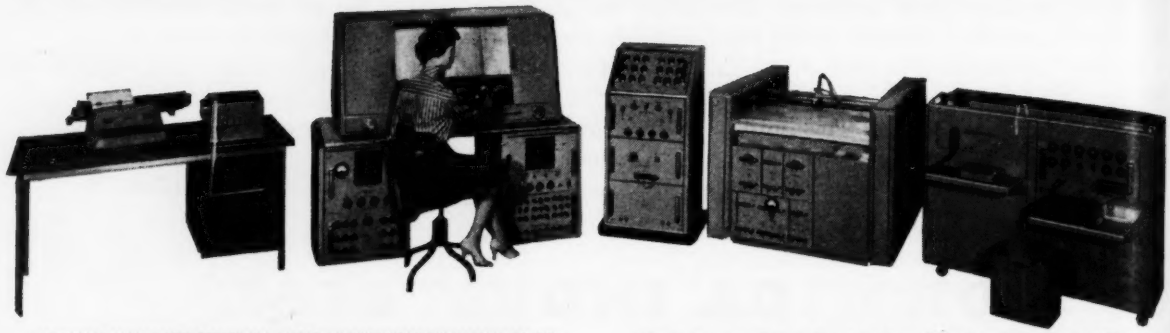

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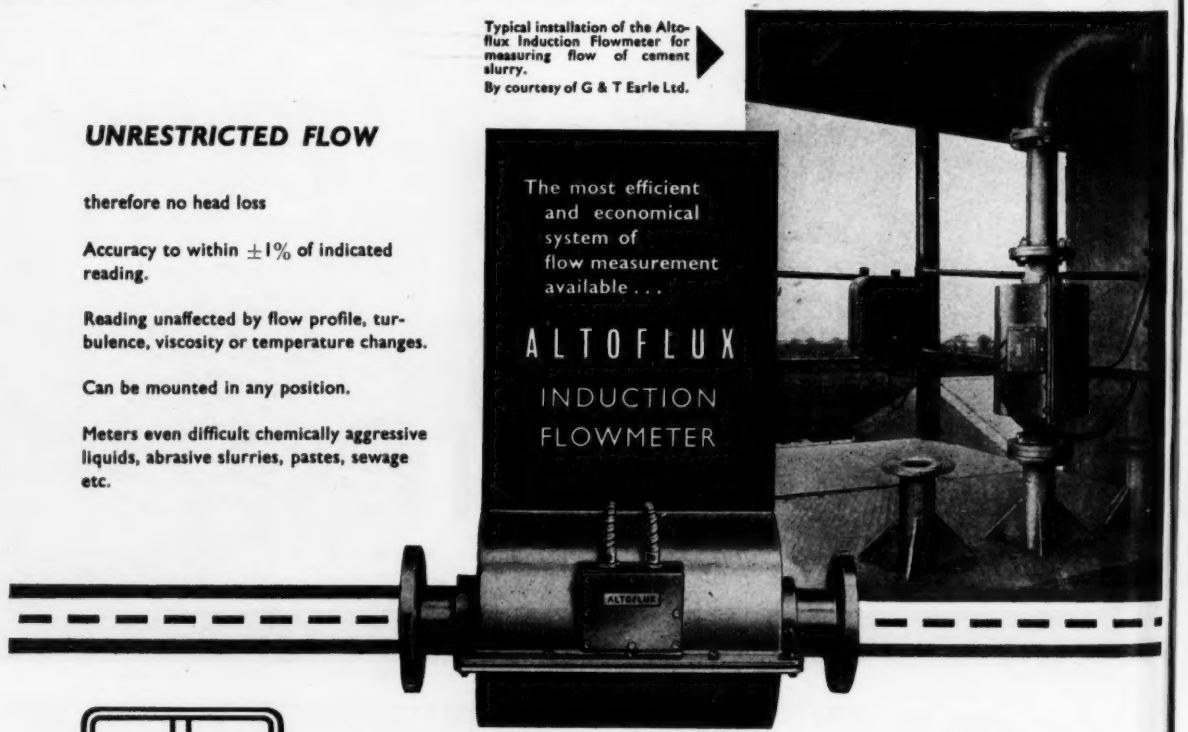

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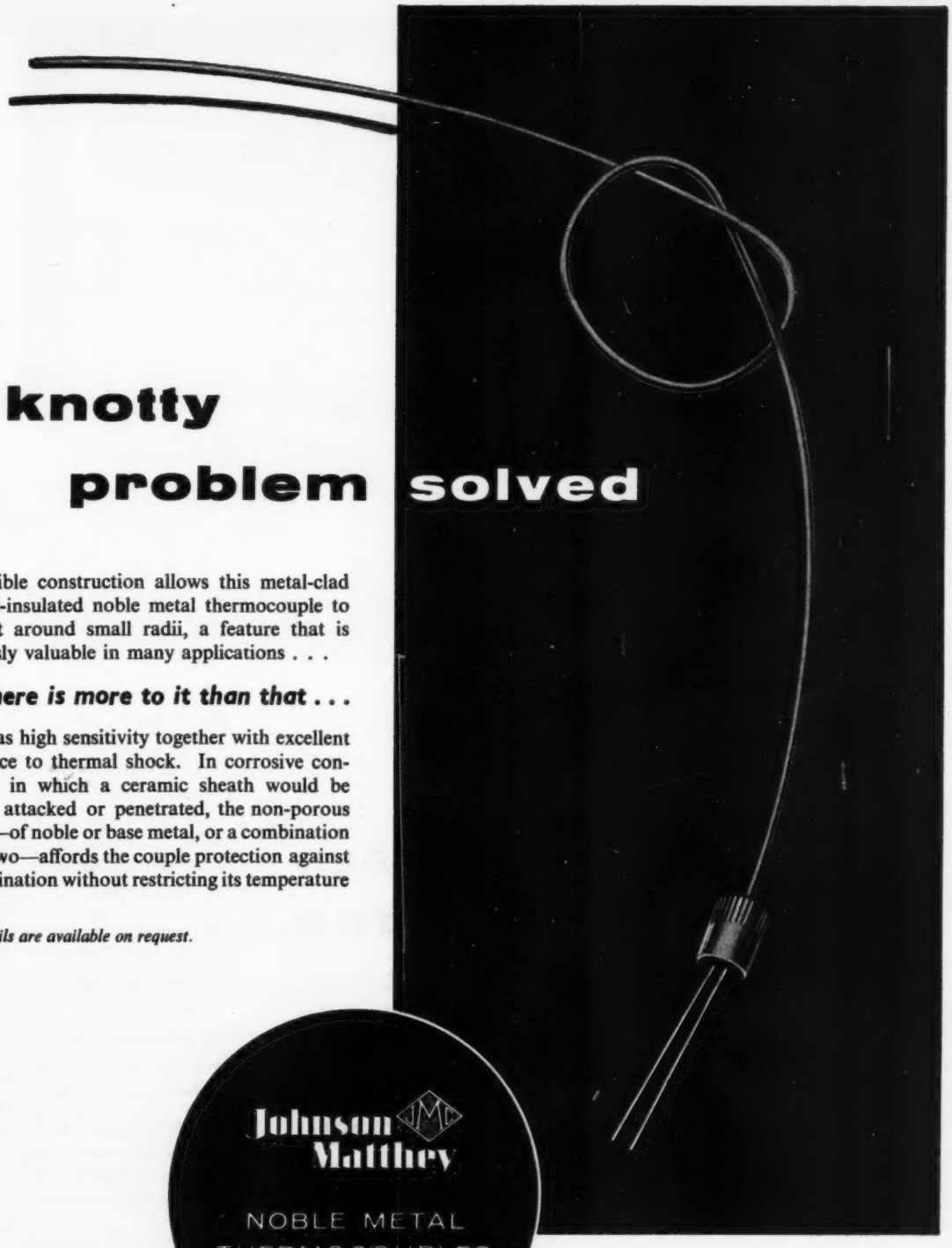

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CONTENTS November 1961

	Page
Automatic Control and the Application of Linear Theory. Part 1. *By G. V. Greatorex, A.M.I.E.E., Dipl.Eng., A.Inst.E. and B. E. Adams, B.Sc.*	1381
Aquascan: an Instrument for Measuring the Undissolved Water in Aviation Fuels	1386
The Effect of a Complex Flow Distribution on the Performance of a Suppressed Weir *By R. G. West*	1389
Radiant Panel Igniter *By J. H. McGuire*	1398
Polarograph Scanning System *By H. C. McIntyre, M.A., M.C.I.C.*	1400
Report on the Third International Convention on Analogue Computation *By Dr. C. M. Cundall*	1403
Instrumentation in Chocolate Manufacture. Part 3. The Development of Confectionery Production Machinery *By R. D. Hoskin*	1404
A Report on the Electronic Computer Exhibition and Symposium	1408
Instrumentation in Water Research	1412
Equipping the Steel Industry	1414

Regular Features

Commentary	1379	Personalities	1461
Sima Notes	1415	Manufacturers' Literature	1462
New Instruments	1419	Society of Instrument Technology	1464
News of the Industry	1449	Forthcoming Exhibitions and Conferences	1468
Instrument Applications	1459		

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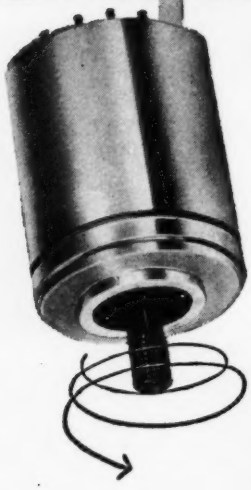

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INSTRUMENT PRACTICE

COMMENTARY

Medical Electronic Instruments

In the commentary for last month (October, 1961), which dealt with instrumentation and the saving of life, reference was made to the influence of instrumentation in diagnostic and curative medicine. Perhaps one may be permitted to quote the concluding sentence of the relevant paragraph. " One can be sure of one fact, however, that medical instrumentation, generally, is in its infancy, and the next decade will see some great advances." The subject is given an added interest by an announcement in our American contemporary *Instruments & Control Systems*. In the September, 1961 issue (unfortunately not received when the previous commentary was written) is the summary of an amendment to a Bill relating to public health, etc., passing though Congress. The amendment calls attention to some striking figures. In 1960 the U.S.A. Government was spending **$2** billion* dollars for military electronics research, development, testing and evaluation. In the same year precisely **$2** million was allocated to medical electronic research. Converting these figures to pounds sterling we have the relative figures of £714,000,000 and £714,000 respectively. In either currency, the amount spent on electronic medical research is one thousandth of that on military electronics. Of course, some of the techniques developed in the one sphere can be used in the other. In fact there is a particular reference to microminiature instruments which telemeter physiological data from outer space. These, it is stated, are already beginning to find their way into clinical use. But even if one sets this possibility on the credit side, the fraction mentioned above seems to be lamentably small. This is evidently the opinion of the mover of the amendment since the text refers to the rather modest rate at which clinical applications are proceeding and logically says that the pace could be quickened if more funds were available. A particular case is given as a support for new thinking in this direction. Quoting the original text: " In spite of the many millions of dollars expended for heart research and the efforts by scientists in virtually all countries of the world to improve the treatment of heart disease, there is no method available today to provide the physician with a continuous record of cardiac output. This would provide a great advance in the treatment of heart disease. Currently available electronic instruments can provide continuous records of pulse rate and blood pressure. In evaluating the cardiac patient for ability to return to his job or to his previous environment the physician needs to know the response of the heart to exercise. The ability of the heart to pump additional amounts of blood during exercise is the one vital measurement that the average physician cannot make today. The inability of the physician to judge accurately the ability of the heart to pump blood under exercise conditions constitutes a hazard to all cardiac patients ".

This is the view of Professor W. G. Kubicek of the Department of Physical Medicine and Rehabilitation, University of Minnesota. It seems an odd lapse in the development of the cardiograph pattern of instrument, and still more striking is the fact that, apparently, none of the countries represented at the Medical Electronics Exhibition of 1960 can provide such an instrument.

The amendment makes certain recommendations, one of which is to establish two regional instrument centres, the suggested sum to be allocated to the establishment is **$1,500,000** or £503,600. Remembering the scale of United States efforts in other fields, this would appear to be a very modest sum. If, on the other hand, it is regarded as adequate, the cost of parallel developments in other countries might very well be less. This brings us to a consideration of the United Kingdom's effort in the medical electronics field. There is an established centre for medical research at Mill Hill—The National Institute for Medical Research—which has an instrument department and has carried out several developments in the medical electronic instrument field. Then again, the main hospitals have all contributed to the development of essential instruments.

The United States proposals if translated here would seem to imply the establishment of a Medical Electronics Instrument Research Association. Whether this would be greatly superior to the present method of research, *if co-ordinated*, is a matter for consideration, but the mention of co-ordination brings us to another clause in the amendment which has as its objective " Authorisation of foreign currencies for international research, at not less than the level proposed by the administration." International research is a difficult entity to establish, but medical electronics is surely one field in which it is possible since there need be no political aspects. There is already one international body in existence—The International Federation for Medical Electronics—which although young has been very active. Its powers, at the moment, are restricted to the development and dissemination of knowledge in medical electronics, but this is an important function, for there is much to be done in a relatively short space of time and the duplication of effort through ignorance of progress elsewhere must be avoided. One final question may be posed, even if it has a familiar ring. Is our effort adequate at the moment or for the immediate future or does it need to be greatly increased to play our part in international medical electronic instrumentation?

* American billion

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Fig. 1. Block diagram showing basic concept of closed loop control

Automatic Control and the Application of Linear Theory

Part 1

By G. V. GREATOREX, A.M.I.E.E., Dipl.Eng., A.Inst.E., and B. E. ADAMS, B.Sc.*

Introduction

AUTOMATIC control is being increasingly applied in every branch of engineering, with the express purpose of improved performance with less reliance on the necessity for human effort. Indeed, many modern engineering developments would be completely impracticable without automatic control of some kind.

The basic concept of closed loop control is easily brought out by a simple block diagram (Fig. 1). The term " Closed Loop " is used to indicate the continuous signal path for the error E through G and H.

The system without the feedback link H is simply an open loop device with the output, whatever it may be, directly dependent upon the value of G. G is usually subject to variation due to its dependence on power supplies and environment, etc.

From the block diagram we may develop the elementary closed loop equation as below.

In the forward path $O = GE$

In the feedback path the feedback signal $= OH$

the error $E = I - OH$

Hence eliminating the error

$$O = I \frac{G}{1+GH}$$

and the output is less dependent upon changes in G. Clearly, it is advantageous to increase G. However, we find that the individual devices constituting G and H have finite response time. This produces phase changes round the loop, and can result in sufficient feedback at certain frequencies to cause sustained oscillation of the system. This is the prime consideration for the application of control theory.

Control System Analysis

Control system analysis is really the art of producing equations from which we can define the behaviour of a system when on closed loop—that is to say, when the technique of feedback is employed to reduce an error signal at some point in the loop to a minimum value.

There are two basic parts to a control system, the system to be controlled and the controller, which is incorporated to improve system performance. This is achieved in the process industry generally by the use of conventional 3 term controllers. These are devices which have a very wide built-in range of parameter adjustment, and are essentially computers which take the error between a demanded and an actual output and operate on this error in such a way as to produce a restoring action at the output of the plant. In practice the parameters are adjusted by empirical methods to give satisfactory plant response. However, many people are faced with problems where the performance required would fall short if one of these controllers were used, without system analysis. This is often the case when a system has to produce a given bandwidth or some other specified criterion. Linear

* English Electric Co. Ltd.

analysis will help us to meet the requirements of the system specifications, but this work should be backed up by laboratory prototype models if possible.

System Transfer Functions

The concept of transfer function is one which is necessary to the control engineer and is a mathematical expression for system behaviour. By means of the Laplace transform theory the system response to various types of input may be obtained. The production of these transfer functions is the design starting point, and a simplified version of the actual transfer function is often used. If the device is non-linear we may obtain a small perturbation transfer function which will describe the small-signal behaviour of the individual part for a given design condition. Methods do exist to deal with non-linearities but these will not be treated here.

Transfer functions for electric motors, heaters, generators, amplifiers, measurement transducers such as flow meters, thermocouples and most process transducers are reasonably easily calculated and show surprisingly good agreement with measured values. It is usual to produce the transfer functions as the first step in designing a control system, and here lies the problem, for if standard transfer functions are not available, some fundamental work is necessary to produce them.

Transfer functions for any available system are best evaluated by means of practical testing methods. The best known of these is the frequency response method. This method is widely used in practice and special instruments are available which enable a frequency response to be obtained even when noise or harmonics are present.

One particular instrument virtually produces the transfer function directly. Useful information may also be gained from the step response.

The Laplace Transform Operator

The Laplace transform operator is the key to rapid solution of linear differential equations. An application of the Laplace transform to the step response of an electrical circuit is shown here to bring out the relative simplicity of this method and to emphasise its strength as a mathematical tool for the engineer.

Consider an electrical integrator circuit, Fig. 2.

By simple current balance we have,

$$i = \frac{V_1 - V_2}{R} = C\frac{dV_2}{dt}$$

hence

$$V_1 = V_2 + RC\frac{dV_2}{dt}$$

Applying the rule for the transform of a derivative of a function:

$$\frac{d\psi}{dt} = S\psi - \psi_0$$

where ψ_0 is the value of ψ at time $t = 0$.

we have

$$V_1 = V_2 + RC\,(S\,V_2 - V_{2_0})$$

$$\therefore \qquad V_2 = \frac{V_1}{1 + S\tau} + \frac{\tau V_{2_0}}{1 + S\tau} \qquad \ldots\ (1)$$

Where the heavy type indicates transformed quantities and τ is the time constant RC.

If we consider equation (1) and make the initial condition equal to zero we obtain:

$$\frac{\mathbf{V_2}}{\mathbf{V_1}} = \frac{1}{1 + S\tau}$$

This is defined as the transfer function of the RC network considered and is known as a first order lag of time constant τ seconds. The system transfer function enables us to find the steady-state response of any input when sufficient time has elapsed for the effect of the initial conditions to decay away.

For the majority of cases in control system analysis the initial conditions may be considered zero and the system transfer function gives the response for all time immediately after the input is applied.

In order to find the time response to an input we look up in Laplace transform tables the transform of the input we are considering. Next we multiply this by the system transfer function, and thirdly by use of the Laplace transform tables we find the inverse of the resultant transform. This is the required time response.

For example, take the simple network considered previously with zero initial conditions:

$$\mathbf{V_2} = \frac{\mathbf{V_1}}{1 + S\tau}$$

For a step input of amplitude A:

$$\mathbf{V_1} = \frac{A}{S}$$

$$\therefore \qquad \mathbf{V_2} = \frac{A}{S\,(1 + S\tau)}$$

Looking up Laplace transform tables:

$$V_2 = A\,(1 - e^{-t/\tau})$$

A more simple way to obtain the transfer function of a network containing inductors and capacitors is to make use of the concept of operational impedance **Z.** Where

$$\mathbf{Z} = SL \text{ for an inductance L}$$

and

$$\mathbf{Z} = \frac{1}{SC} \text{ for a capacitor C}$$

Using this conception we can produce directly the transfer function for the RC network in Fig. 1, as follows:

$$i = \frac{V_1 - V_2}{R} = \frac{V_2}{1/SC}$$

Hence

$$\frac{\mathbf{V_2}}{\mathbf{V_1}} = \frac{1}{1 + SRC} = \frac{1}{1 + S\tau}$$

In practice a transfer function usually has a constant factor associated with it. In the example taken the output voltage may have been applied across a resistance R_0. In this case the transfer function would be:

$$\left\{\frac{R_0}{R + R_0}\right\}\left\{\frac{1}{1 + S\tau\,\dfrac{R_0}{R + R_0}}\right\}$$

The actual time constant is reduced by the factor $\dfrac{R_0}{R + R_0}$ and a constant factor $\dfrac{R_0}{R + R_0}$ has appeared as a fixed " gain ".

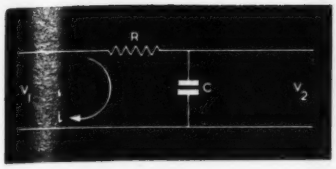


Fig. 2. Integrator circuit

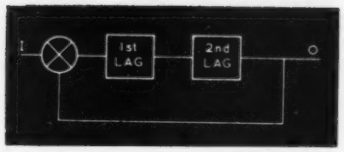


Fig. 3. Elementary system with two lags closed with straight feedback

Block Diagrams

Once the transfer functions are approximately known for each block in the proposed control system, a block diagram is drawn up. This block diagram is constructed of rectangular boxes and connecting links with the respective transfer functions drawn in the boxes. It is a good plan to include the expected saturation levels for all of these boxes at output or input, as the case may be.

It should be noted that the block diagrams are constructed in such a way that the product of all the constant factors round the loop should result in a dimensionless quantity defined as the system gain. If the system is a simple one, we may now be able to produce a direct answer to the question of stability.

Consider an elementary system of two lags closed with straight feedback (Fig. 3), we have a differential equation describing the closed loop behaviour of the following form:

$$a\frac{d^2O}{dt^2} + b\frac{dO}{dt} + cO = I$$

This equation may be evaluated by classical methods, and the solution which results will indicate immediately whether the system is to be stable or unstable. However, higher order systems offer a serious problem, in that the solution of the differential equation becomes a very tedious business, even by the Laplace transform method, since denominator roots have to be extracted of polynominals of the same order as the order of the differential equation. Several short-cut methods are available for control system analysis and two of these will be described.

The Bode Diagram

The Bode diagram is a short-cut method of establishing the maximum permissible gain for a given system and also the expected closed loop frequency response. This diagram enables us to rapidly run through a range of possible configurations to get a preliminary "feel" for the system. In order to use the Bode diagram it is first of all necessary to obtain the transfer function of each block in the loop. As mentioned earlier these will either be obtained theoretically or by measurement.

In general the majority of transfer functions can be reduced to one of two simple transfer functions of the form:

$$\frac{1}{1+S\tau} \text{ and } \frac{1}{1+\frac{2\xi S}{\omega_n}+\frac{S^2}{\omega_n^2}}$$

or products of these.

The first of these corresponds to a simple lag with a time constant of τ seconds. The other represents a second-order system with a natural frequency of ω_n radians/second and a damping factor ξ. ξ is defined as the ratio of the actual damping present in the system to that required to produce critical damping. For critical damping $\xi = 1$ and the quadratic can then be factorised into two simple lags with a coincident break point at $\omega = \omega_n$.

In order to obtain the frequency response of any system it is only necessary to replace S by $j\omega$ in the system transfer function.

Consider a simple lag of the form $G(S) = \dfrac{1}{1+S\tau}$

putting $S = j\omega$

$$G(j\omega) = \frac{1}{1+j\omega\tau}$$

i.e. $$G(j\omega) = \frac{1-j\omega\tau}{1+\omega^2\tau^2}$$

$$\angle G(j\omega) = -\tan^{-1}(\omega\tau)$$

$20 \log_{10} |G(j\omega)|$ is known as the gain in decibels (dB). For insertion on the Bode diagram Fig. 4, we plot frequency on the logarithmic axis and gain (in decibels) on the vertical linear axis.

When $\omega = \dfrac{1}{\tau}$

$$\left|G(j\omega)\right| = \frac{1}{\sqrt{2}} = 0{\cdot}707$$

and $\angle G(j\omega) = -45°$

This point where $\omega = \dfrac{1}{\tau}$ is known as the "break point." The result plotted for all values of ω shows a curve which may be approximated by two straight lines. One line has zero slope and the other a slope of

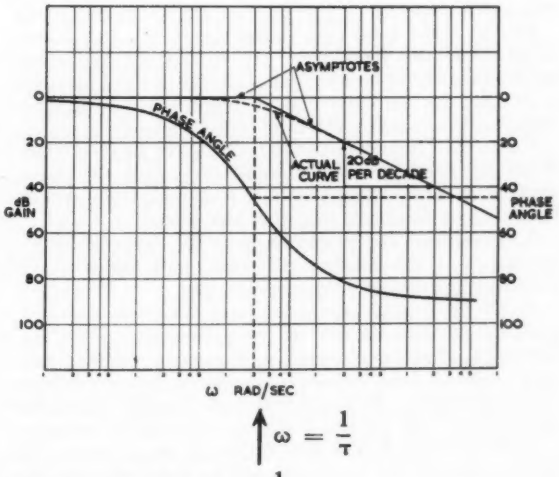


Fig. 4. Bode plot of $\dfrac{1}{1+\omega\tau}$

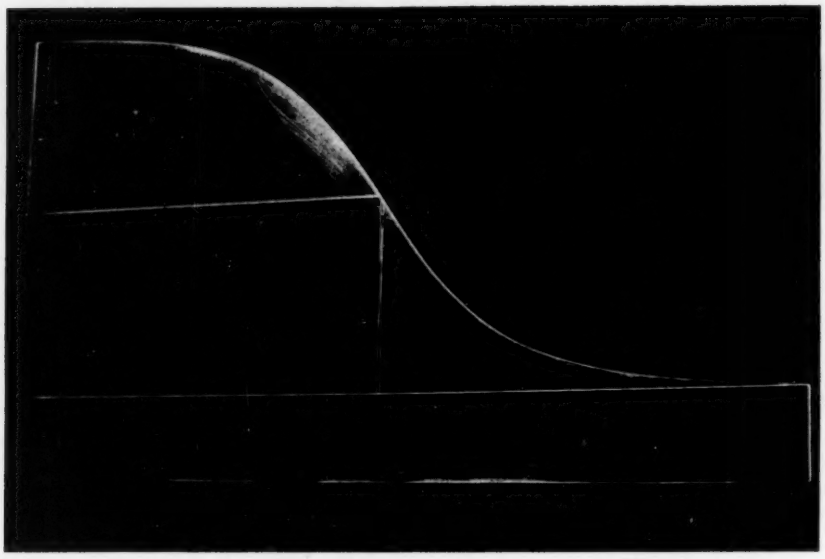


Fig. 5. Plastic template for plotting phase angles

20 dB/per decade of frequency. These lines intersect at the break point and are asymptotic to the curve at the high and low frequency ends. We are able to make use of this fact in the construction of Bode diagrams for quite complicated systems by adding or subtracting slopes at each break point. From this we produce the approximate open-loop frequency response.

In order to determine the stability of the system it is necessary to calculate the total phase angle at the frequency corresponding to unity open-loop again.

The phase angle due to a single lag is best plotted by use of a plastic template, Fig. 5, designed for the particular graph paper used. This enables a curve of the form shown in Fig. 4 to be traced. It is used by setting the 45° point on the template at the break point frequency and tracing in the curve.

Fig. 6 shows a plot for a system with 4 break points due to 3 lags and 1 lead. The open-loop gain has now to be inserted on the diagram, and we shall then be in a position to estimate the expected degree of stability of the system, and the approximate closed-loop frequency response.

In Fig. 6 the total gain round the circuit was taken as 20 dB at zero frequency. As we increase frequency we see that the open-loop gain falls off until ultimately it crosses the zero dB line at point (B). It is now important to consider the total phase angle at this point.

From the Nyquist criterion for stability we know that if the gain is unity, in any closed-loop system, the phase angle must not exceed 180°. If it should, there would be sufficient feedback to cause oscillation.

To determine the phase angle at the point of intersection we add algebraically the individual phase contributions of each transfer function.

If, for the control system we have designed, the total phase angle exceeds 180° at the intersection point, we would then have to re-design and possibly include more lead terms to cancel some of the lag, and hence reduce the phase angle. In practice the phase angle is usually set to about 130° to give a reasonable stability margin.

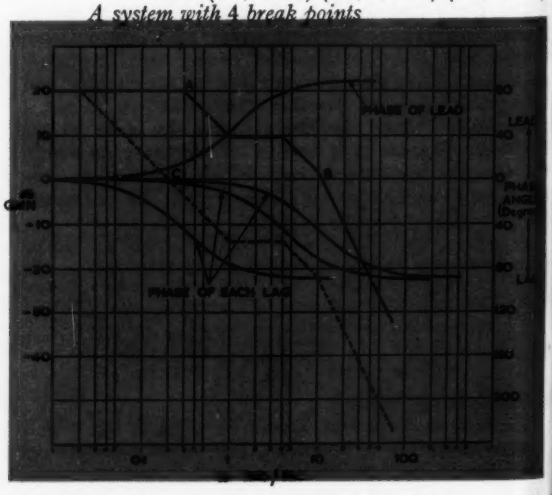
It should be noted on Fig. 6 that an improvement in the bandwidth has been achieved by using the closed-loop system, since the first break point at (A) would obviously give rise to a small bandwidth on open loop. If bandwidth were of no consequence here, a system could quite easily be stabilised with the same d.c. gain simply by increasing one of the time constants. This separates the break points and lowers the phase angle at the new point of intersection (C). In Fig. 6 this would be a change of time constant from 3·3 to 50 seconds.

Reference here should be made to the Nicholl's chart, which is a chart designed so that the closed-loop frequency response can be read off directly the open-loop information has been plotted.

The Root Locus Method

This is a method of graphically determining how the closed-loop roots of a system vary with changes of open-loop gain. It has the special advantage over frequency response methods in that items may be included in the analysis which have imaginary roots in

Fig. 6. Bode plot of $\dfrac{10\,(1+S)}{(1+3{\cdot}3S)\,(1+0{\cdot}25S)\,(1+0{\cdot}1S)}$ *A system with 4 break points*



their transfer functions, such as resonant circuits, or under-damped servo loops. A further important feature of the root locus method is that it enables the designer to include in the analysis the effect of transport delay and distributed transport delay effects which occur in process control.

Consider the closed-loop expression

$$\frac{G(s)}{1 + G(s)\,H(s)}$$ where $G(s)\,H(s)$ is of the form

$$G(s)\,H(s) = K\left[\frac{(1 + T_1S)\,(1 + T_2S)}{(1 + T_aS)\,(1 + T_bS)\,(1 + T_cS)}\right]$$

Then we require to find the locus of the root of the expression

$1 + G(s)\,H(s) = 0$ as K is varied. For any point on the locus the equation

$1 + G(s)\,H(s) = 0$ must apply:

and $\therefore\ G(s)\,H(s) = -1$

i.e. $\angle\ [G(s)\,H(s)] = n\pi$ where n is odd

and $|\,G(s)\,H(s)\,| = 1$

Steps to take

(*a*) *Rewrite transfer function in the form*

$$K\,\frac{T_1\,T_2}{T_a\,T_b\,T_c}\left\{\frac{\left(\frac{1}{T_1} + S\right)\left(\frac{1}{T_2} + S\right)}{\left(\frac{1}{T_a} + S\right)\left(\frac{1}{T_b} + S\right)\left(\frac{1}{T_c} + S\right)}\right\}$$

Now let $\dfrac{T_1\,T_2}{T_a\,T_b\,T_c} = A$

$$\therefore\quad GH = KA\left\{\frac{(\quad)(\quad)}{(\quad)(\quad)(\quad)}\right\}$$

Now $-\dfrac{1}{T_1} - \dfrac{1}{T_2}$ etc. are the roots of the numerator, i.e. zeros, and $-\dfrac{1}{T_a} - \dfrac{1}{T_b} - \dfrac{1}{T_c}$ etc. are roots of the denominator, i.e. poles. The numerical values of these are the starting points for the root locus plots. Note that the poles and/or zeros could be complex, of the form a + jb.

(*b*) *To Plot the Locus*

Construct a diagram on linear graph paper with the same scale on each axis, plot the poles and zeros, marking the zeros with O and the poles with X.

Now choose an arbitrary point, q, as a test point. For this point to lie on the locus it must satisfy the following condition: lines drawn from the test point to the poles and zeros make angles to the real axis, and the algebraic sum of these angles must be equal to $180° \pm n\,360°$, where n is an integer.

All angles are measured in an anti-clockwise manner, poles positive, zeros negative.

Fig. 7 shows the root locus plot for the transfer function:

$$\frac{(1 + 0{\cdot}2S)}{(1 + 6S)\,(1 + 2S)\,(1 + 0{\cdot}2S)}$$

and here we see that seven successive test points were required to draw a complete locus. At the point q given in Fig. 7, the angles are $89{\cdot}5 + 79{\cdot}5 + 35{\cdot}5 - 22{\cdot}5 = 180°$. The point q therefore lies on the locus.

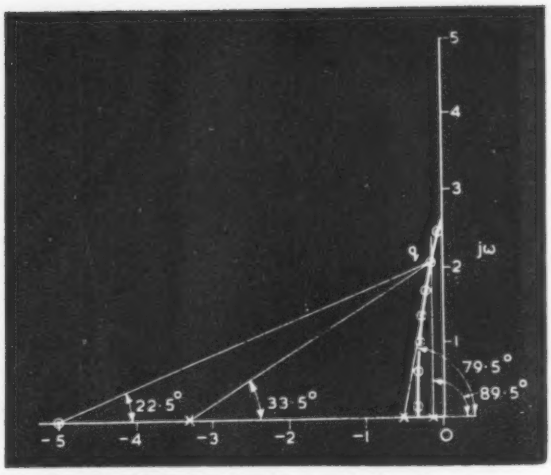


Fig. 7. Root locus plot for the transfer function $\dfrac{(1 + 0{\cdot}2S)}{(1 + 6S)\,(1 + 2S)\,(1 + 0{\cdot}2S)}$

Calculation of Damping Factor

Often it is found that as the gain K is increased the locus crosses the imaginary axis. The value of ω corresponding to this point is the natural frequency of the system for zero damping. Any further increase in gain will give a condition of continuous oscillation. A reduction of gain is equivalent to increasing the damping factor, and this is read off the diagram as cos ψ. (ψ is the angle subtended to the real axis by a line drawn from the origin to the point considered on the locus.)

Calculation of Open-loop Gain

In order to calculate the value of open-loop gain corresponding to any point on the locus we proceed as follows:

Draw lines from each of the poles and each of the zeros to the point considered.

Using the second condition that the point should lie on the locus, we have $|\,GH\,| = 1$.

$$\text{i.e. } K\,\frac{T_1\,T_2}{T_a\,T_b\,T_c}\,\frac{\left|S + \frac{1}{T_1}\right|\left|S + \frac{1}{T_2}\right|}{\left|S + \frac{1}{T_a}\right|\left|S + \frac{1}{T_b}\right|\left|S + \frac{1}{T_c}\right|} = 1$$

$$\text{and } K = \frac{T_a\,T_b\,T_c}{T_1\,T_2}\,\frac{\left|S + \frac{1}{T_a}\right|\left|S + \frac{1}{T_b}\right|\left|S + \frac{1}{T_c}\right|}{\left|S + \frac{1}{T_1}\right|\left|S + \frac{1}{T_2}\right|}$$

$$= \frac{1}{A}\,\frac{\text{(Product of vectors' lengths drawn from the poles to the point)}}{\text{(Product of vectors' lengths drawn from the zeros to the point)}}$$

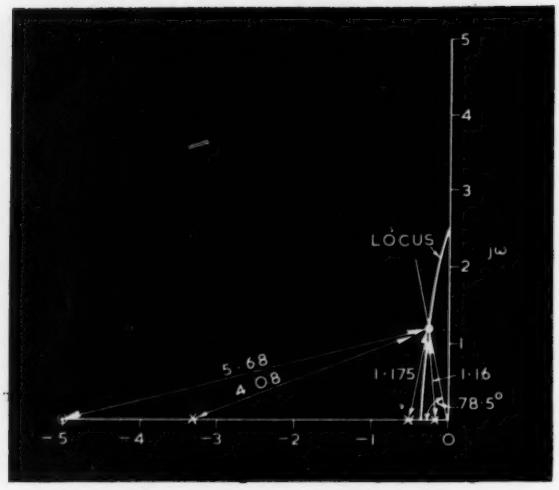


Fig. 8. Root locus plot to give a damping factor of 0·2 for the expression plotted in Fig 7

Example:

Let us find the gain required to give a damping factor of 0·2 for the expression plotted in Fig. 7. This is re-plotted in Fig. 8 to show the method of construction.

For a damping factor of 0·2; cos $\psi = 0{\cdot}2$ and $\psi = 78° 30'$. A line is drawn through the origin making an angle of 78° 30′ with the real axis. This line meets the locus at the point q′.

Lines are then drawn from the poles and zeros to the point q′ as shown, and the lengths of these measured.

The gain is given by

$$K = \left[\frac{6 \times 2 \times 0{\cdot}3}{0{\cdot}2}\right]\left[\frac{1{\cdot}16 \times 1{\cdot}175 \times 4{\cdot}08}{5{\cdot}68}\right] = 17{\cdot}6$$

(Part II will be published next month)

AQUASCAN

An Instrument for Measuring the Undissolved Water in Aviation Fuels

ONE of the major problems occurring when water is present in turbine fuel is icing of the aircraft fuel system components during prolonged flights at high altitude. Fuel heating systems are fitted into aircraft to combat this problem, but this means additional weight in the aircraft, and also an increase in fuel consumption.

Dissolved water is always present in aviation fuels, the amount depending on fuel temperature and composition, and providing it remains in the dissolved state it does not have any adverse effect on engine operation. It is the undissolved water content of turbine fuels that is the criterion as far as satisfactory aircraft fuel system operation is concerned and 30 p.p.m. maximum is currently proposed as an acceptable figure for undissolved water content of turbine fuel as loaded into aircraft.

The figure 30 p.p.m. was selected because it was considered that with the determination methods available for field use none would detect a level below 30 p.p.m. with certainty.

The detection, measurement and control of the undissolved water content of fuel loaded into aircraft is of extreme importance in the elimination of aircraft operational hazards. The high rates of flow used in an aircraft refuelling meant that intermittent sampling for the determination of water content was unsatisfactory and a continuous monitoring system with a fast response time was what was required.

Work was started at the BP Research Centre, Sunbury-on-Thames, on the development of an instrument to detect undissolved water in aviation turbine fuel. A survey of the possible methods indicated that one based on a light absorption principle seemed most promising.

Principle of Operation of the Aquascan

If undissolved water is present in turbine fuel in a finely dispersed state the fuel will have a cloudy appearance, the degree of cloudiness depending upon the concentration and droplet size of the water present. It is possible under these conditions to measure the quantity of undissolved water present by a direct light absorption technique. It is important, however, that a consistent particle size distribution is maintained in such a dispersion in order to achieve accurate results. Also this method is only of use if compensation can be provided for any changes in the light absorbance characteristics of the turbine fuel and for the effects of particulate matter which may also be present.

The instrument is designed as a light absorption comparator in which two beams of light, from a single source, are compared photo-electrically after each has passed through associated liquid-filled absorption cells. One absorption cell contains turbine fuel as sampled from the fuel delivery stream and the other contains a sample of the same fuel at an elevated temperature, the sampling being done on a continuous basis. When undissolved water is present in the stream from which the samples are drawn, the fuel entering one of the absorption cells is cloudy, whereas the fuel entering the other cell is clear since the water is in solution at the elevated temperature. A condition is therefore achieved which allows for the optical comparison of the turbine fuel

containing water droplets with a clear sample of the same fuel, and a measure of the light absorption due to the undissolved water can be made.

For such measurements to be established on a quantitative basis, however, it is necessary to ensure that the water droplets in the turbine fuel feed to the instrument have a consistent particle size distribution. This is necessary since the amount of light absorbed is dependent on the particle size of the undissolved water. Tests have shown that the particle size distribution of the dispersion produced by the centrifugal pump of the fueller is sensitive to pump speed. Of necessity, therefore, the fuel feed to the instrument is passed through a disperser which modifies the size of the water droplets to meet requirements.

With an optical system of this type it is apparent that entrained air would also cause light absorption, in a similar manner to the water droplets, and so give rise to erroneous water indications. Air separators are, therefore, included in the sample fuel system.

Description of the Instrument

The instrument consists of two parts, an optical comparator unit and an indicator and control unit. These are connected by electrical cables (Fig. 1).

In the BP Aquascan there is a light-absorption comparator in which two beams, from a single light source, are compared photo-electrically. One beam passes through an absorption cell filled with fuel exactly as sampled from the fuel delivery stream; the other beam passes through an identical cell, but in this case the fuel is heated. This heating causes any undissolved water in the fuel to pass from suspension to solution and thus cease to be visible. In the second

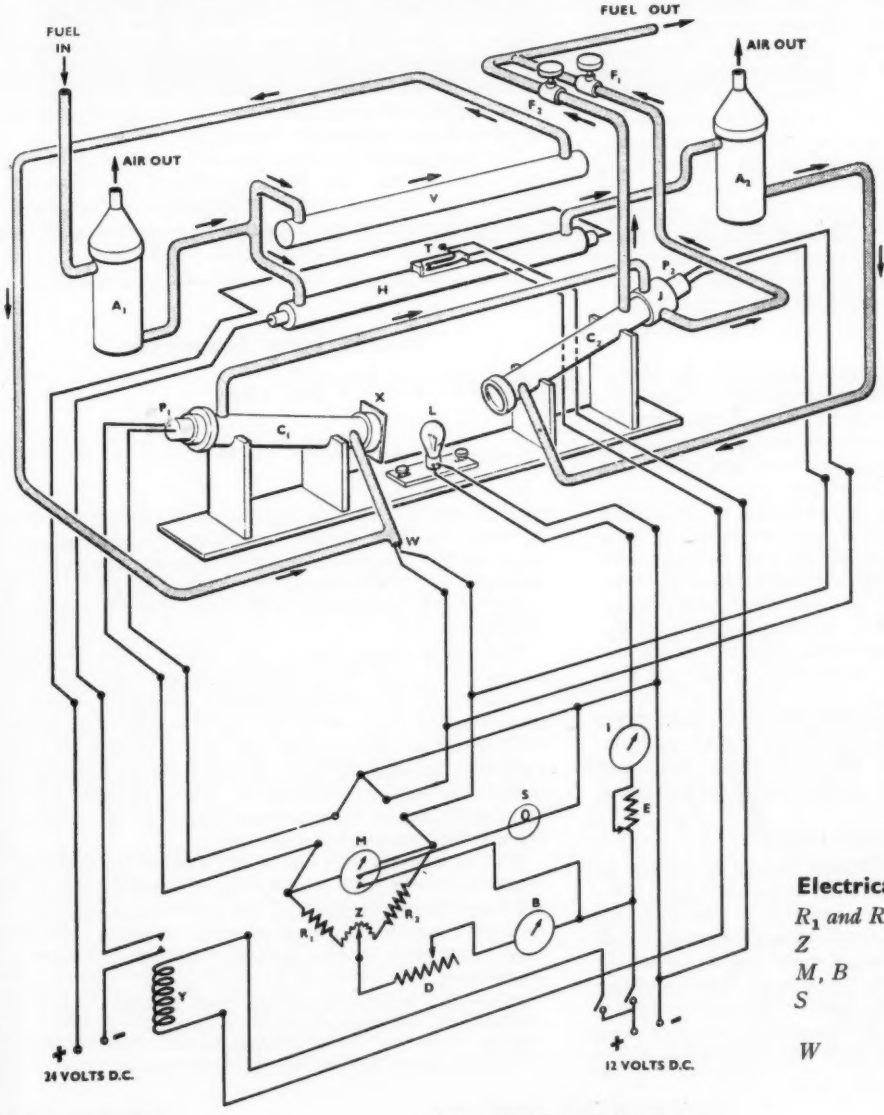


Fig. 1. Simplified layout and electrical circuit of the BP Aquascan

Optical Unit

L—24 W lamp mounted on an adjustable bracket

C_1 and C_2—8 in. long optical absorption cells, sealed at the end swith Perspex discs

P_1 and P_2—photo-resistive detectors

A_1 and A_2—air separators

H—line heater

T—bi-metallic excess temperature cut-out

V—capacity vessel

J—heat exchanger

F_1 and F_2—valves

X—calibrating absorber of semi-opaque plastic sheet

Electrical Unit

R_1 and R_2	*fixed resistors*
Z	*zeroing potentiometer*
M, B	*milliammeter*
S	*lamp on instrument panel*
W	*total water detection device*

cell there is therefore a reference fuel identical with the fuel being delivered in all respects except one—its light-absorption potential. An optical comparison of the two samples, the cloudy and the clear, will therefore indicate the degree of light absorption in the unheated sample which can be attributed only to the presence of undissolved water. The amount of this light absorption is shown on a dial calibrated in parts of undissolved water per million parts of fuel. If the undissolved water content of the fuel exceeds the recognised permitted maximum quantity, an automatic shut-down device is actuated, stopping the flow of fuel. The electrical power for the Aquascan is supplied from the fueller batteries, 22 amp at 24 volts and 2·5 amp at 12 volts.

The Optical Unit

Turbine fuel is fed to the optical comparator through a cyclone type air separator A_1 with a coalescer section of glass spheres, having previously passed through an electrically-driven disperser. Air from the separator is bled out through a restriction at the apex of the conical section and a slight flow of fuel is also maintained from this outlet under operating conditions. The de-aerated fuel stream from the separator is split in two by suitable pipe arrangements. One half of the stream is passed through a line heater H to a second air separator A_2 before entering the absorption cell C_2. The line heater has an excess temperature cut-out T fitted to its metal surface which is set to switch off the power to the heaters should the turbine fuel flow become abnormally low. The other half of the stream passes through a capacity vessel V, which has a volume sufficient to equalise the amount of fuel in the two systems, to the absorption cell C_1.

Fuel from cell C_1 is used as a coolant for the photo-resistive detector P_2 by passage through a heat exchanger J which is an integral part of the detector housing. This ensures that the detectors are operating under similar temperature conditions and eliminates drift in the electrical balance setting.

Two valves F_1 and F_2 are included in the outlet streams from the absorption cells so that the flow from the two halves of the system can be equalised. Inclined mounting of the cells and the connecting of the outlet pipes at the highest levels ensures good purging and avoids the trapping of air bubbles during start-up. The inlet pipes to the absorption cells are located to produce a swirl across the respective cell end plates to prevent liquid stagnation.

For calibration purposes a mechanism for inserting a fixed optical absorber J between the cell C_1 and the lamp L is provided, the absorber being calibrated before use as representing a specific water concentration.

The Indicator and Control Unit

The indicator and control unit houses the electrical components associated with the detector bridge network and the lamp current adjuster. The milliammeter M is fitted with an adjustable contact and is used for indicating the out-of-balance signal and for switching an alarm circuit at a pre-set signal level. Closing of the alarm circuit is shown by the lighting of lamp S mounted on the instrument panel. In the unlikely event of pure water being substituted for aviation fuel a total water detector W, comprising a two-pin probe inserted into the fuel stream, is connected in parallel across one arm of the bridge so that an immediate alarm signal is given.

The installation includes a shut-down device, operated by an electrical signal from the meter so that fuelling is automatically stopped when the water content of the fuel exceeds the pre-set limit.

The sample stream is fed to the disperser at a much higher flow rate than required by the instrument, the excess fuel being piped back to the fueller tank. This prevents heating of the fuel in the disperser which would cause water to be taken into solution. Two outlet lines from the disperser include control valves which are set to give the required distribution of flow between the two streams. A pressure gauge is included in the feed to the instrument for use as a flow rate indicator, the flow rates having been set with the valves provided in the optical unit.

Initially a prototype instrument was fitted to a fueller to determine whether or not it was sufficiently robust to withstand field usage. The instrument was not used for monitoring fuel, but after five months' service tests showed the instrument was still in good working order and the calibration unchanged.

The development project has now reached the stage that instruments are being produced by Thermal Control Co. Ltd. to meet the immediate requirements for the monitoring of undissolved water in aviation fuels.

Photometric Standards and the Unit of Light

THE historical evolution of light standards and the way in which the NPL today maintains a steady unit and scale for the measurement of light is the subject of a monograph " Photometric Standards and the Unit of Light ", published in the NPL series Notes on Applied Science.

The early pages trace the development of light sources from the early nineteenth century and the evolution of the present primary standard. In the main part of the booklet the story is told of how the NPL maintains the unit of light, of how it prepares and calibrates standard lamps, and of work which goes on behind the scenes to ensure the closest possible agreement with similar measurements made in other official laboratories throughout the world.

This monograph will not only appeal to the specialist but will also provide a useful and resonably complete reference source in its field for other scientific laboratories, for manufacturers of all types of lamps, and for others engaged in the general field of illuminating engineering.

" Photometric Standards and the Unit of Light " by J. S. Preston, M.A., M.I.E.E., F.Inst.P., F.I.E.S., N.P.L. Notes on Applied Science No. 24. Published for D.S.I.R. by H.M.S.O. Price 3s. (by post 3s. 4d.). U.S.A. 54 cents.

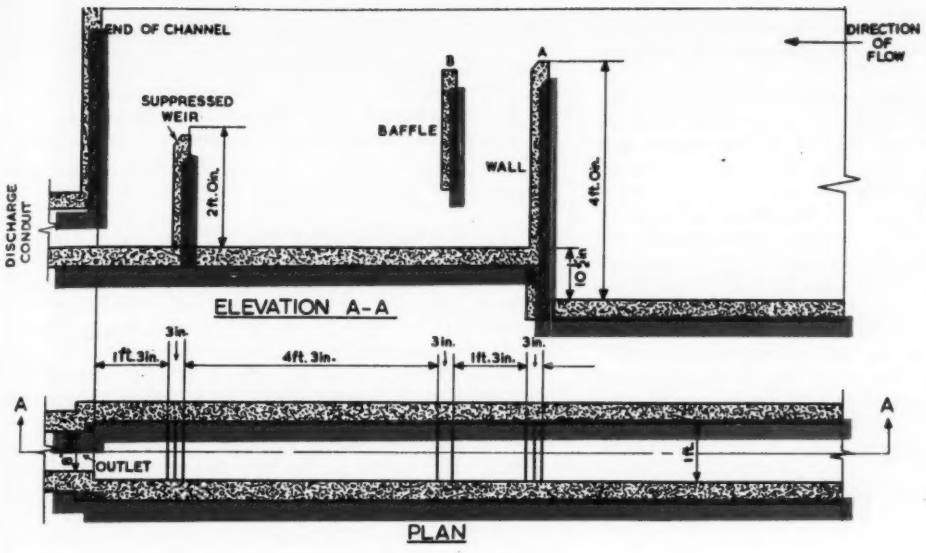


Fig. 1.
General layout of channel with weir installed in it

The Effect of a Complex Flow Distribution on the Performance of a Suppressed Weir

By R. G. WEST Head of the Fluid Dynamics Laboratory, Electroflo Meters Co., Ltd.

Introduction

PREVIOUS articles in this series have emphasised that unrestrained empiricism can lead to confusion and even to error when attempts are made to draw general conclusions from specific instances of information obtained by purely empirical methods.

In this article an investigation almost entirely empirical in character is described.

The justification is that theory could give only a general idea of the solution to the problem, and that no general conclusions could, or would, be drawn from the test results.

Description of Problem

This problem was first revealed by the flow line characteristics on the chart of a float-operated weir recorder.

Such a well-known type of instrument needs no description, and it is sufficient to remark that the float responds to the water level upstream of a suppressed weir. The general layout of the channel in which the weir is installed is shown in Fig. 1.

The peculiar characteristic shown on the chart, Fig. 2,

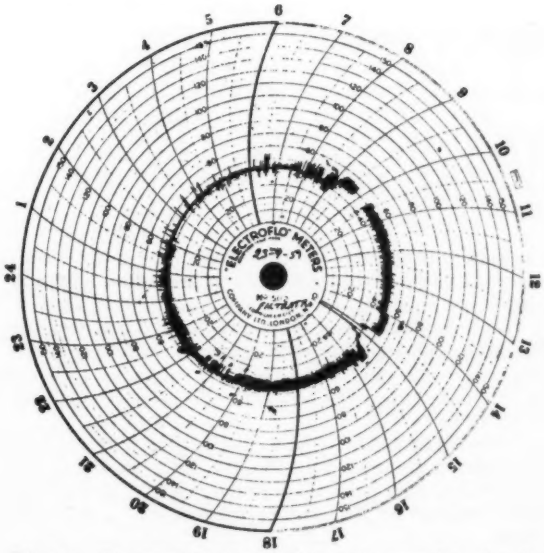


Fig. 2. *Chart of float-operated weir recorder showing flow-line characteristic*

in no way represented the true flow conditions which were, in fact, very steady and of reasonably constant rate.

Eventually it was observed that the free overfall at point A (Fig. 1) entrapped air in its fall so that the water in the compartment formed by the wall A and the baffle B was a seething mixture of air and water. Although some of the entrained air was swept away, there was, every minute or so, enough air collected in this compartment to cause a serious obstruction to the water flow. As a result, this air in the form of one huge bubble or pocket was forced under and through the gap between the baffle and channel bed. Once through the gap, the air rose to and broke the water surface in a most decisive fashion, and in so doing caused a shock wave to travel to the weir plate; it was this wave and its associated waves which produced the characteristic line shown on Fig. 2.

At the same time, the reduction in free area in front of the baffle due to this air pocket accentuated the jet effect downstream of the baffle.

Model Tests Proposed

In view of the fact that the plant was operational and that constructional changes would be both difficult and expensive, it was decided to use a 1 : 2 scale model in an attempt to find some simple way of rectifying this condition, as well as to establish whether it caused any error in measurement. The weir plate itself was machined mild steel and was carefully prepared for each set of tests.

The model was fitted with glass viewing panels. In addition, although such a change at site was unlikely, the model baffle 'B' was movable so that the effects of re-positioning it could be tried if all else failed.

Level measurements were made with a vernier point gauge.

Nature of Tests

The original head/flow relationship for the weir had been calculated using the Rehbock formula:

$$Q = b\left(3{\cdot}23 + 0{\cdot}43\,\frac{h}{p} + \frac{0{\cdot}018}{h}\right) h^{\frac{3}{2}}$$

p = Height of weir crest above channel bed
b = Width of channel
h = Head on weir

and it is quoted here because inspection of the terms of the equation provides a guide to the tests eventually made.

This formula is one of the many derived traditionally from the orifice analogy which gives a basic equation:

$$Q = \int_0^H C_d \,.\, b \,.\, \sqrt{2gh} \,.\, dh \quad \ldots\ldots\ldots\ldots \quad (1)$$

The coefficient of discharge C_d has to be determined experimentally and has in the past been related to the head H over the weir. This practice has more recently been modified so that the expression for C_d is of the form:

$$C_d = C_c + \frac{x_1}{h} + \frac{x_2 h}{p} \quad \ldots\ldots\ldots\ldots \quad (2)$$

where C_c = the theoretical contraction coefficient

$$= \frac{\pi}{\pi + 2} \text{ approximately}$$

x_1 is a capillary or viscous influence correction

x_2 is a velocity of approach and contraction correction.

These two equations (1) and (2) form a discharge equation of the general type:

$$Q = \tfrac{2}{3}\, C_d \,\sqrt{2g} \,.\, b \,.\, \phi\left(x_1 \,,\, x_2 \,,\, h^{3/2}\right)$$

We are not concerned here with the "absolute" performance of suppressed weirs and it is convenient to use this formula. However, the treatment is fundamentally unsatisfactory, and only recently has a better approach been made. [Paper 1453 'Journal of the Hydraulics Division' *Proc. A.S.C.E.*, "Discharge Characteristics of Rectangular Thin-plate Weirs"—Carl E. Kindsvater and Rolland W. Carter. December, 1957.] This paper is the only recent attempt of any importance to put weir measurement theory on an acceptable basis.

Firstly, it should be said that all weir formulæ are valid only if the velocity distribution in the channel upstream of the weir is normal.

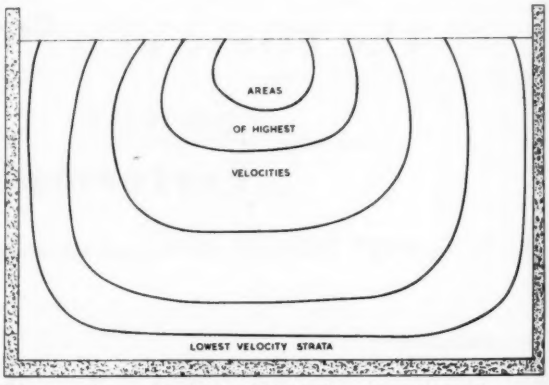
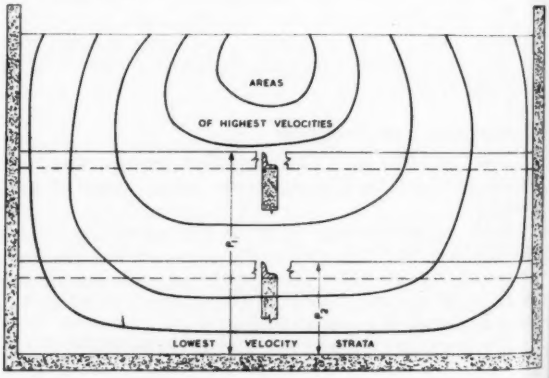


Fig. 3. Normal velocity distribution in a channel

Fig. 4. Weir plate with crest at varying height (p) from the channel bed



Normal distribution has yet to be defined, but is taken to mean the distribution that obtains in a reasonably wide and deep channel of consistent cross-sectional area over a great enough length to enable the flow regime to become stable—providing such flow is sub-critical or tranquil. The results of a distribution traverse in such conditions are shown in Fig. 3. The arrangement of the "Isovels"* is characteristic and has lead to the use of certain depths as spot checks of the mean velocity in the channel.

The importance of the distribution is indicated by Fig. 4 in which a weir plate is shown with its crest at alternative heights from the channel bed. This height is denoted by the symbol p in the Rehbock formula. It is clear that the value assigned to p will decide:

(a) the degree to which the higher velocity strata are obstructed;

(b) the extent to which the flow in the lower strata next to the channel bed will be subject to directional change—Fig. 5.

The significance of the obstruction effect is further apparent if it is remembered that with small values of p only the low velocity strata are blocked. Under this circumstance, therefore, the bulk of the flow will flood over the weir and velocity of approach influence will override the genuine accelerative effects of the weir plate.

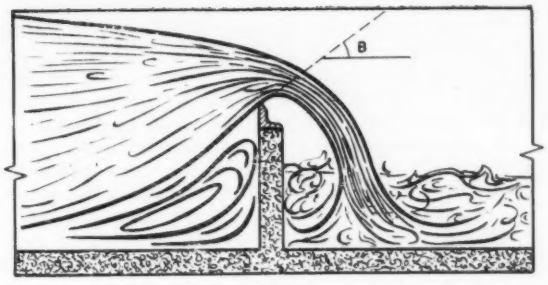
Thus, in practice, the rate of discharge will depend on the water depths and mean velocities (if a range of flow is to be measured). On the other hand, for the same upstream depth, large values of p mean that almost all the main bulk of flow is interrupted by the weir plate; that considerable momentum exchange is involved and this results in a marked contraction leading to the formation of the nappe shape which is characteristic of a correct weir flow mechanism. Both of these matters influence the important $\frac{h}{p}$ ratio which is in effect a measure of vertical contraction.

In combination with the channel and weir plate width B and b respectively, $\frac{h}{p}$ provides an area ratio similar to that denoted by 'm' in closed pipe measurement.

If now, for an installation with established values of h and p, the velocity distribution is changed so that there is a preponderance of high velocity strata near the channel bed, the effect will be to alter the contraction angle B, Fig. 5. This in turn will raise the nappe formation over the weir and thus reduce the values of the discharge coefficient.

It is feasible to take this argument one stage further and show that there is a risk that the lateral conditions of flow may also be changed. A suppressed weir has $\frac{b}{B} = 1$, but an unnatural velocity distribution at the bottom of the channel can lead to a nappe formation essentially convergent in the lateral sense due to "draw-in". In which case $\frac{b}{B} \neq 1$ will cause a further reduction in the value of the discharge coefficient.

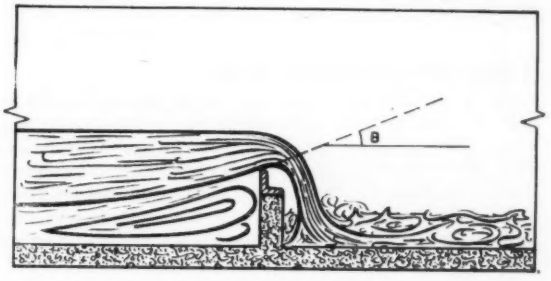
*Lines of equal velocity.



(*a*)

Fig. 5. Weir plate with its crest at different heights from the channel bed. The extent to which the flow will be subjected to directional change may be compared in (*a*) *and* (*b*)

(*b*)



Influence of the Baffle

A further examination of Fig. 1 in the light of the above remarks can now be made. The gap beneath the baffle, although of normal proportions for this type, is restrictive even for the normal distribution shown in Fig. 3, and tends to create a high velocity jet near the channel bed.

It is surprising to find that this form is still used. There are few occasions when it can be called a happy choice. It is particularly unsuitable as a means of "improving" the flow or velocity distribution before a flow measurement structure such as a weir or flume.

The recommendation of such baffles should be discontinued.

This type however can be used, as eventually in the present case, to block shallow surface waves or ripples, but it only needs to be of very limited depth if undesirable effects are to be avoided.

The influence of the baffle is much aggravated by the free overfall. Quite apart from the entrapped air pocket, there will be a tendency for the vertical stream to establish a stable path through to the channel floor and to the gap under the baffle, which will merely preserve rather than destroy this flow path.

Well established strata of this sort persist and will, without difficulty, reach the weir plate. Thus the hypothetical conditions already used in discussing the formula are present.

Evidently, the air pocket will make the jet condition worse, since the submerged water stream will be

squeezed between this pocket and the channel bed.

The one essential requirement is therefore to reduce the potential energy of the falling water stream. There is no room between the baffle and the weir plate for a second vertical baffle and, even if there were, it is doubtful whether any advantage would be gained.

It was therefore decided to concentrate on some arrangement of horizontal baffles or steps within the compartment formed by wall A and the baffle B.

The idea was to encourage energy losses by:

(1) preventing a continuous fall;
(2) causing the water jet to break-up and impinge on the vertical surfaces A and B.

However, the variation in the angle of impact of the step with rate of flow would cause these losses to vary slightly.

In addition, it was thought that by momentarily interrupting the water fall and breaking it up, there would be less chance for air to be entrapped and a better chance for air that had become trapped to escape upwards.

Trials with Horizontal Baffles

As a preliminary trial, an arrangement shown in Fig. 6 consisting of three steps in V-formation was used. The results were disappointing; one reason was that the horizontal spread of water blanketed the gaps, which, in plan, are themselves restrictive, between the steps and the vertical walls. In this way at least the same amount of air was forced down which, coupled with the reduced velocity of the falling water, enabled greater amounts of air to collect before the air pocket could be forced through the gap under the baffle.

In this test and all those that followed, flow rates and levels in the model were adjusted and correlated to the prototype on the basis of the non-dimensional group $\frac{V}{\sqrt{gd}}$ generally referred to as the Froude number. For a model whose linear scale to the prototype is 1 : n the following relationships apply on this basis:

$$Q\ (\text{model}) = \frac{Q\ \text{prototype}}{n^{5/2}}$$

$$V\ (\text{model}) = \frac{V\ \text{prototype}}{\sqrt{n}}$$

$$d\ (\text{or h})\ (\text{model}) = \frac{d\ (\text{or h})\ \text{prototype}}{n}$$

The choice of the Froude number rather than Reynolds number as a basis for these tests is due to the fact that the problem involves gravity and inertia forces and, not to any great extent, viscosity or surface tension. Even so, it is advisable to have the roughness of the model directly proportional to that of the prototype so that:

$$K_{\text{model}} = K_{\text{prototype}} \times \frac{1}{n}$$

where K = mean roughness height.

In this way friction effects are not ignored, although in any case they are here of secondary importance.

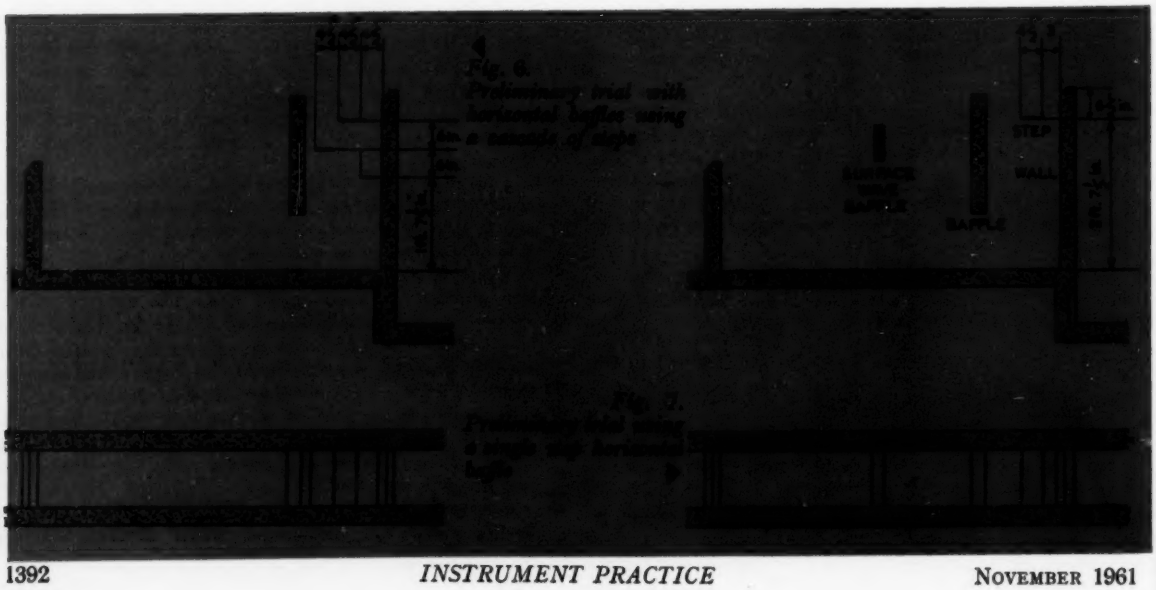
The one uncertainty in the use of the Froude number is the possible effects of quantities of compressible air in the water. Nevertheless, no other non-dimensional group could be used with better advantage.

In view of these preliminary results, the cascade idea was abandoned in favour of a single step, Fig. 7. This decision raised new problems as to the width of the step and its position relative to both the channel bed and to the surfaces A and B.

A first estimate was that the model step width should be about 4 in., that it should be positioned mid-way between the surfaces A and B and 2 feet from the channel bed.

There was no doubt that this was a better arrangement, but the width of the step and/or its position relative to the falling water stream needed revision if the step were to impede satisfactorily at all rates of flow.

In this respect the results shown in Figs. 8 and 9 of a subsidiary investigation are of interest. They confirm that the angle of deflection of the stream of



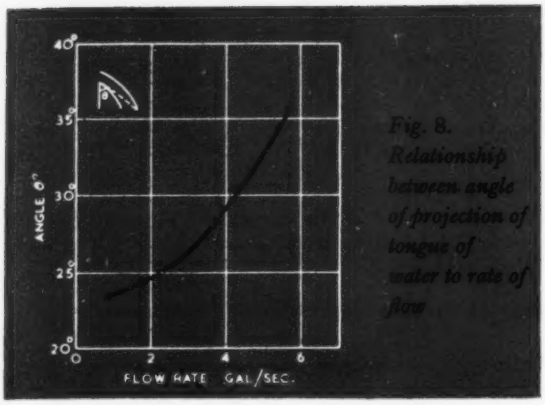


Fig. 8. Relationship between angle of projection of tongue of water to rate of flow

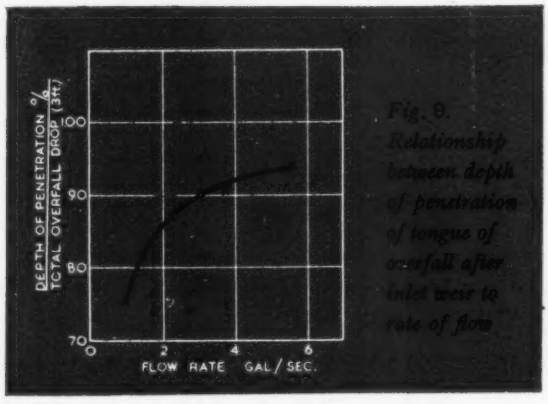


Fig. 9. Relationship between depth of penetration of tongue of overfall after inlet weir to rate of flow

water is in general related to both the rate of flow and to the potential energy available. It follows naturally that the depth to which the falling stream will penetrate below the lower water surface will also be related to these same factors.

However, the results are not entirely in accordance with this expectation due to the cushioning effect of the entrained air.

A width of 4 in. was regarded as an optimum for the step. It was felt that any further increase would be of negative value because, although there would be a greater certainty that the water jet would impinge on the step, there would be a reduction in the free area on either side of the step through which entrained air could escape to atmosphere. In other words, a wide single step would tend to create a similar condition to that obtained with the cascade arrangement.

As there could be the usual variation in rates of flow, it became important to find whether a single step could in fact be so positioned that it would be effective over the required range of measurement.

The results of the subsidiary investigations which are given in Fig. 8 indicated that the angle of deflection would be too great to enable the single step to be fully effective.

Further tests in which arbitrary positions of the step were chosen confirmed this prediction. Fortunately it was later established that, in practice, the installation operated over a smaller flow range than had been anticipated at first. A position of the baffle was then chosen which was completely effective within this range and which only became less efficient at the very highest and least likely flow rates.

Assessment of Tests

In assessing these tests, emphasis was placed on the elimination of turbulence due to entrained air and upon the position of the vertical path taken by the escaping air.

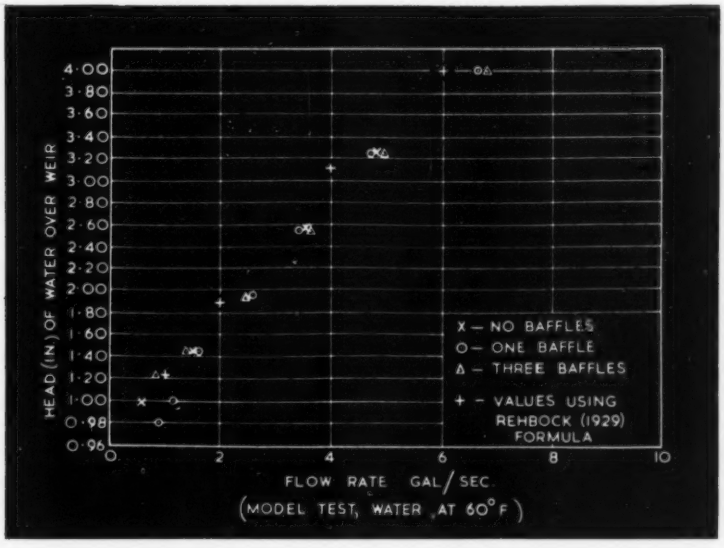


Fig. 10. Comparison of head/flow relationships given by various arrangements of baffles

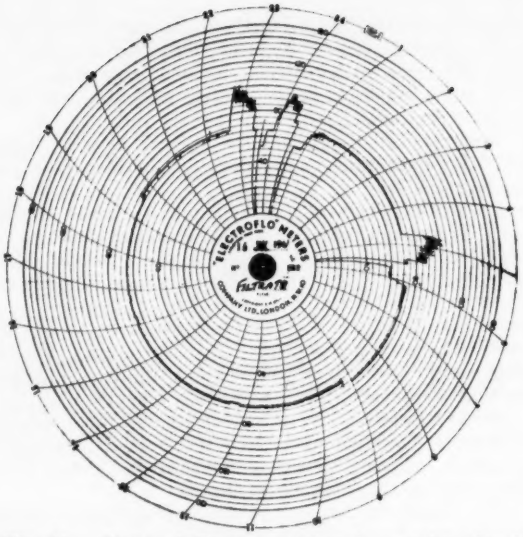


Fig. 11. *Chart of float-operated weir recorder showing improvements in flow-line characteristics*

It proved impossible to avoid minor streams of small bubbles from passing through the gap beneath the baffle. Although the amount of disturbance now caused by these bubbles to the flow line on the chart record was limited, further test work was concerned with this problem and its resolution.

Observation showed that the nature of this disturbance was quite different from the principal aeration. In this case the effect of the small bubble stream was to create a profusion of waves of very small amplitude (approximately $\frac{1}{4}$ in.), not very different from surface ripples or capillary waves.

A baffle which would "skim" these waves from the surface was found to be satisfactory, and since the position of the baffle for that purpose was not critical, it was placed so that there was as large a "pond" as possible before the weir plate.

As a final qualitative check, with the step and surface baffle in position, the path of the below-surface currents was traced with potassium permanganate dye and those on or near the surface with lycopodium powder.

The final stage, and the most important, was to discover whether the apparent improvements had altered the head/flow relation and whether it remained generally in agreement with the Rehbock formula.

The results of the calibration tests using the various baffle arrangements are shown on Fig. 10. The head/flow relationship changed very little for any of these arrangements, but remained slightly lower than that given by the Rehbock equation. However, it has long been recognised that this formula may be unrepresentative for poor conditions and for certain values of b and h/p. For example, Rehbock himself stipulated that the ratio h/p should be as large as possible.

The improvements predicted by this investigation were confirmed at site as can be seen from Fig. 11. One point must be made about this chart: the improvements are of course apparent when compared with Fig. 2, but unfortunately the clients had subsequently found that the range of flows given for purposes of this investigation had to be revised. Higher flow rates were more common and, as already indicated earlier in this discussion, it was known that for these conditions the compromise baffle dimension and position discussed above would not be entirely satisfactory. This is the reason, therefore, the investigation was extended and a means found to eliminate the unsatisfactory chart line at these higher flow rates. For reasons of space, description of this second stage must be left for a future occasion.

Use of Stream and Potential Functions

At this point further comment about the conventional formula is possible in the light of events described above. It is accepted that in this problem two phenomena are involved. One is the effect of the high velocity

Fig. 12 (*a*) *Theoretical flow net for gravity flow under a baffle*

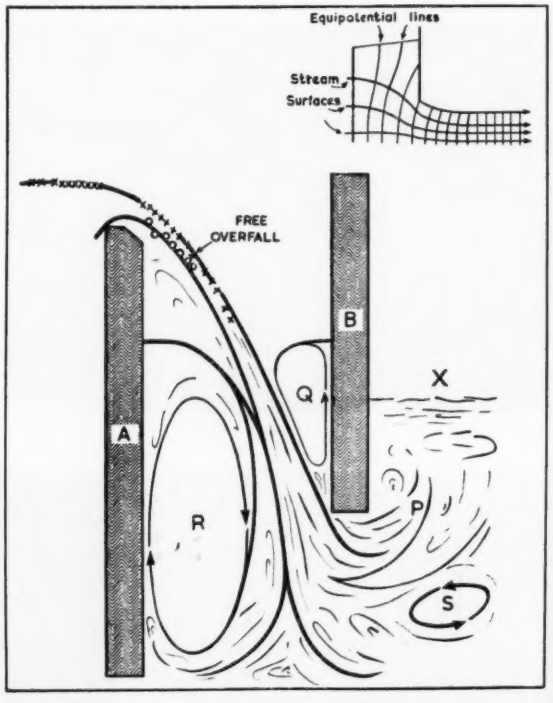


Fig. 12 (*b*) *Actual pattern of flow over a weir and under a baffle. High flow rate* = 6·3 *gal/sec*

P=Heavily aerated stream directionally displaced upwards by the rotational "sense" of the vortex

Q=Secondary area whose rotation and form is not clearly defined due to aeration

R=Secondary area also heavily aerated but stable

S=A vortex condition generated apparently by the very high water velocity along the bed of the channel as far as the weir

X=Ill-defined water surface

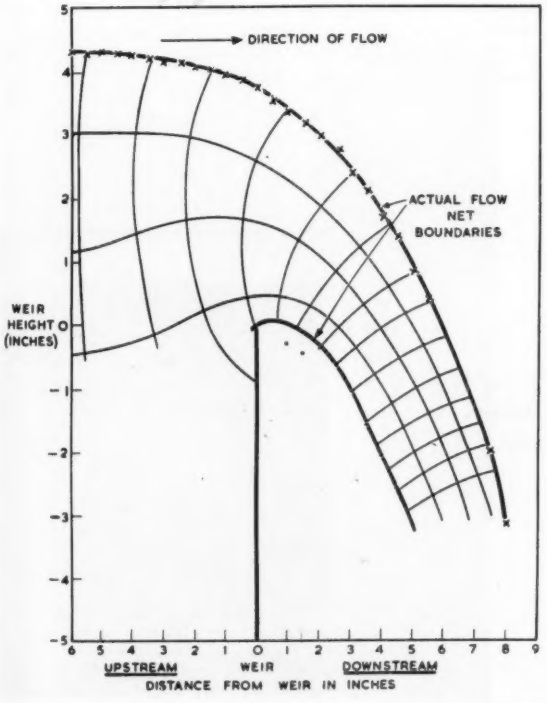
submerged jet; the other is the effect of collection and release of air which increases the contraction beneath the baffle as well as causing the wave type interference to the performance of the weir and its associated instrument.

The use of the stream and potential functions enables a flow net of the type shown in Figs. 12 (a) and 13 to be constructed for gravity flow under a baffle and over a weir. This method is due to Prasil—Schweiz Bauzig—1903.

As is well known, the closeness and distortion of the mesh of the net indicates the extent to which the velocity head agrees at any point with the velocity at that point as determined by the spacing of the potential surfaces. It is obvious that the theoretical flow net over a weir cannot be achieved unless the open net, indicative of steady, uniform flow conditions, can be drawn upstream of the weir. Thus the significance of p is established in a way which is different and yet related to the concept typified by Fig. 4. For a flow net drawn for a weir, for which the value of p has an unsatisfactory relationship to the velocity distribution, would merely be distorted to an extent dependent upon the proportion of flow above the weir sill level, i.e., to the momentum exchange involved.

The practical result is that the secondary flow area in the corner made by the weir plate and channel bed cannot form properly and there will be an incomplete contraction of the water stream over the weir. Thus the choice in values of p which is required in practice is in effect an attempt to adjust the velocity potential pattern immediately upstream of the weir so that if the flow net over the weir were drawn it would correspond very closely to the pattern ideal.

Fig. 13. *Flow net for gravity flow over a suppressed weir. Rate of flow*=75 *gal/sec*



In this case the close proximity of the baffle to the weir means that the closely divided flow net downstream of the baffle clashes with the required open flow net shown upstream of the weir. Therefore, our problem has been to reduce the effect of the baffle so that the length of the high velocity jet is reduced. In this way only can the transition from the closed to the open mesh be achieved in part. The flow net applicable to the present installation before modification would take into account the effect of the free overfall height in forming the high velocity jet under the baffle. As a first requirement, therefore, the characteristics of the flow net can be changed for the better by reducing the effective head on the upstream of the baffle. This reduction can only be achieved practically by energy losses which is the function of the step baffle. However, a flow net cannot take account of aeration. It can be seen from Fig. 13(b) that the actual pattern of flow before and under this baffle is quite complex, and different from that given theoretically. It appears that aeration may help cause a division in the flow and that only part of the high velocity jet goes forward to the orifice plate.

This is the reason why the differences in the head/flow relationships for the various baffle arrangements are small. The fact that they are all higher than for the Rehbock formula does suggest that whatever the installation arrangement, the bed velocities are such as to cause a more marked contraction over the weir. But in any case, there is recent evidence that the Rehbock coefficients tend to be too high and that this tendency is accentuated when restrictive conditions before the weir occur.

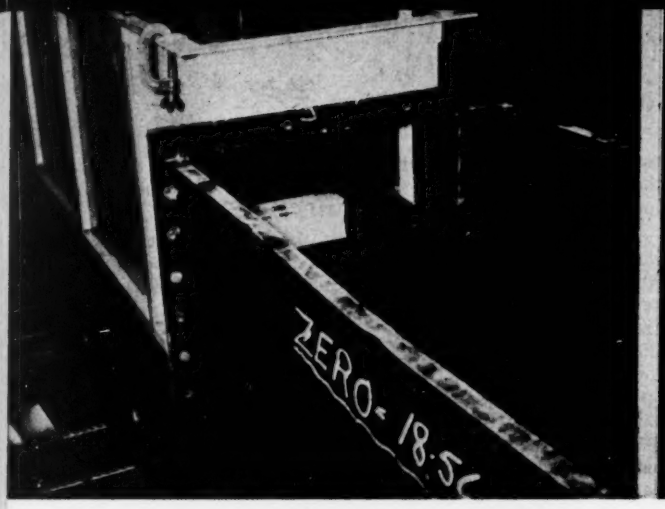
Conclusions

Summing up, therefore, this investigation has shown that the creation by some adverse circumstance of a disturbed surface in front of the weir plate does not necessarily mean that measurement accuracy is affected in an absolute sense, although as in this case the disturbance may be of sufficient magnitude to preclude the possibility of a satisfactory chart record from which the flow rate may be read with precision.

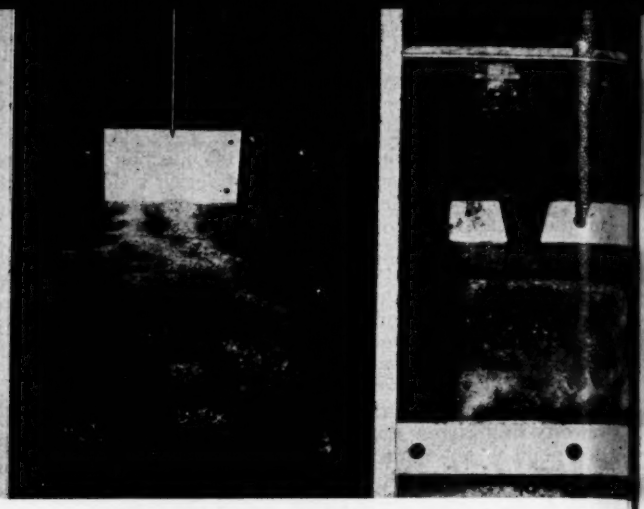
In spite of this it is emphasised that this installation is by no means acceptable and it has been used here to underline the need for greater care in choosing a location if reliable metering is required.

Comments on the Photographic Information

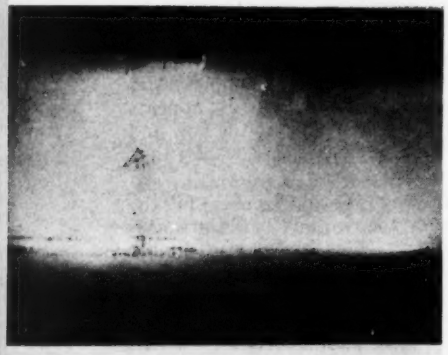
P.1 is a general view of the steel tank with plate glass windows. The nature of the problem is well illustrated by P.2—P.6. The first two of these is a plan view which shows the aeration and general turbulence where the overfall meets the water surface in the tank before the baffle B. Changes in the intensity of aeration and in the penetration of the falling stream below the surface are best illustrated by photographs taken through one of the side windows (P.3—6). The degree of opaqueness is a direct result of air entrainment and by suitable



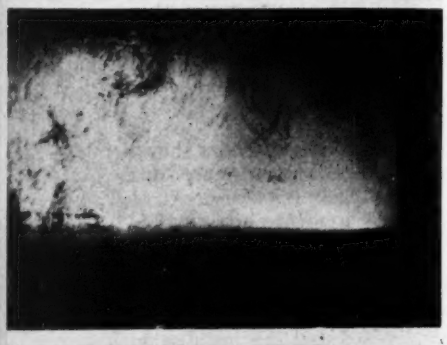
P.1. *General view of the model looking downstream*



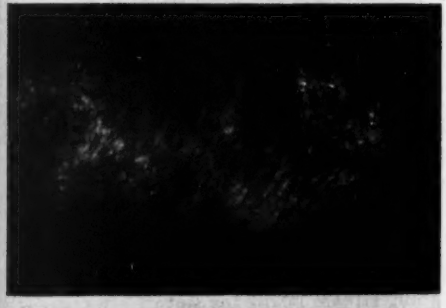
P.2. *Aeration and turbulence caused by overfall*
(*a*) *upstream of baffle B* (*b*) *downstream of baffle B*



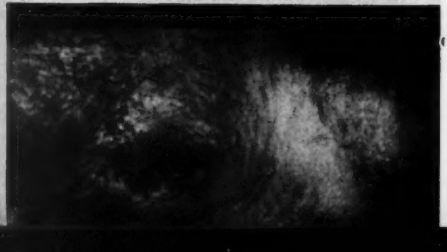
P.3. *Very low rate of flow under baffle B.* 0·9 *gal/sec.*



P.4. *Medium low rate of flow under baffle B.* 2·0 *gal/sec.*



P.5. *High rate of flow under baffle B.* 4·0 *gal/sec.*



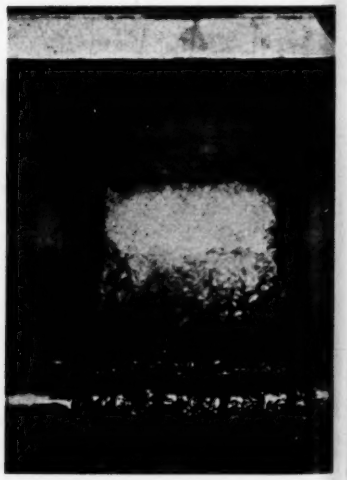
P.6. *Maximum rate of flow under baffle B.* 6·5 *gal/sec.*

exposure speeds it is possible to show the pattern of flow under the baffle at various rates of flow.

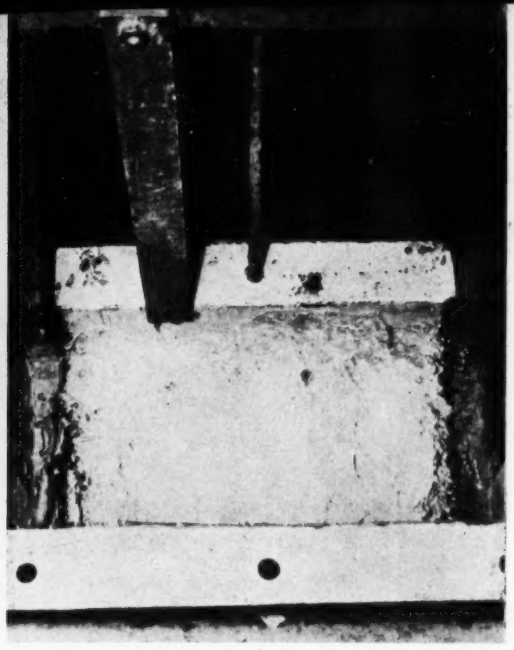
The effect of the condition shown in P.1—P.6 is to upset the stability of the nappe over the measuring weir as can be seen from P.7.

The effectiveness of the single step in diverting the overfall is apparent from P.8; it is of interest to note from P.9 that the same results are obtained on the prototype.

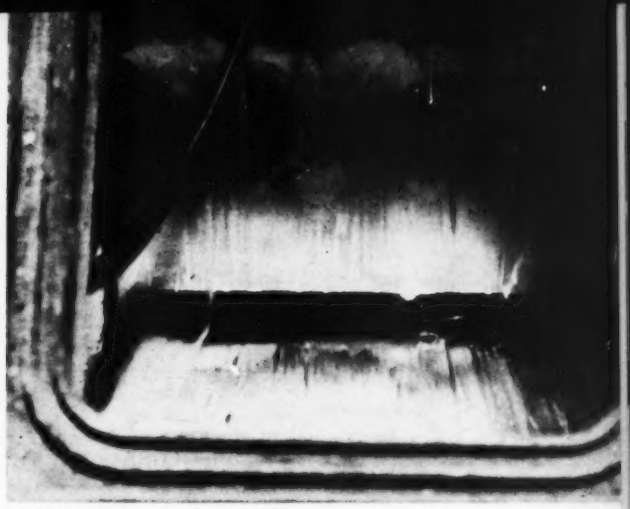
The dissipation of energy in this way produces a tranquil stream almost entirely free of entrained air. It was found difficult to show in the photograph of this improved state, P.10, that water was in fact flowing past the window. The white sheet of paper on the opposite side of the model was in position for all photographs and the extent to which it is visible is directly related to the tranquility of the water flow.



P.7. *Weir nappe disturbed by poor approach conditions*



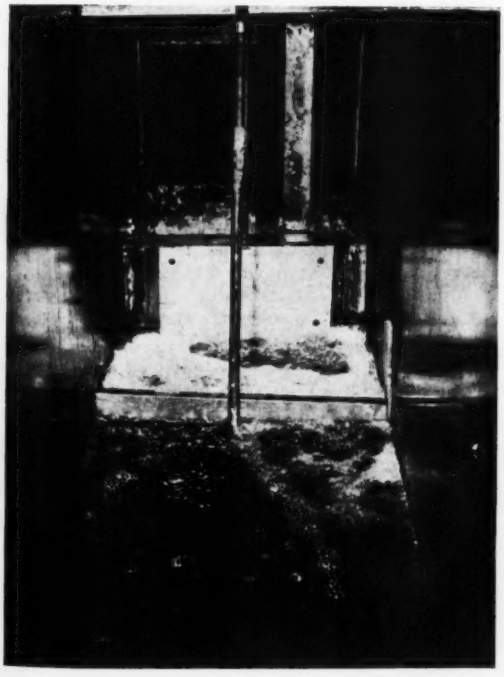
◀ P.8. *Diverting the overfall by a single horizontal baffle or step. Model tests*



▲ P.9. *The same in the prototype*

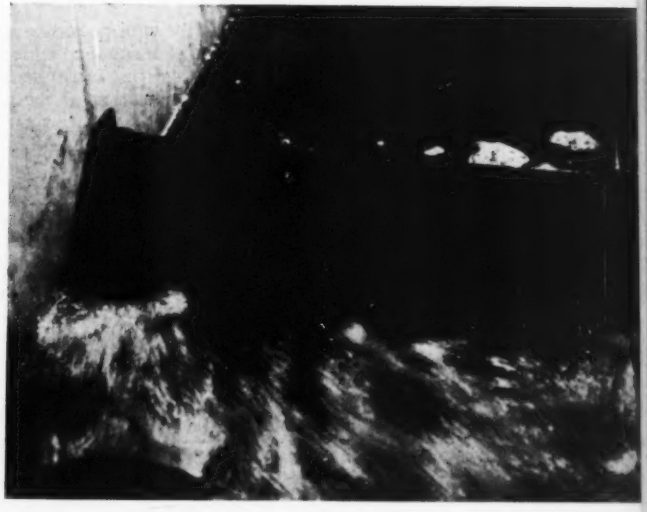
Finally, P.11 shows the surface baffle and the mirror-like surface of the water as it approaches the measuring weir. This compares favourably with the final conditions in the prototype shown in Fig. 12. In the foreground of this photograph is the surface baffle beyond which is a calm water surface at a flow corresponding to a model flow rate of 4 gal per minute.

P.10.
Tranquil, air-free flow under baffle ▶



◀ P.11. *Surface baffle and general view of water surface. Model tests*

P.12. *The same in prototype*
▼



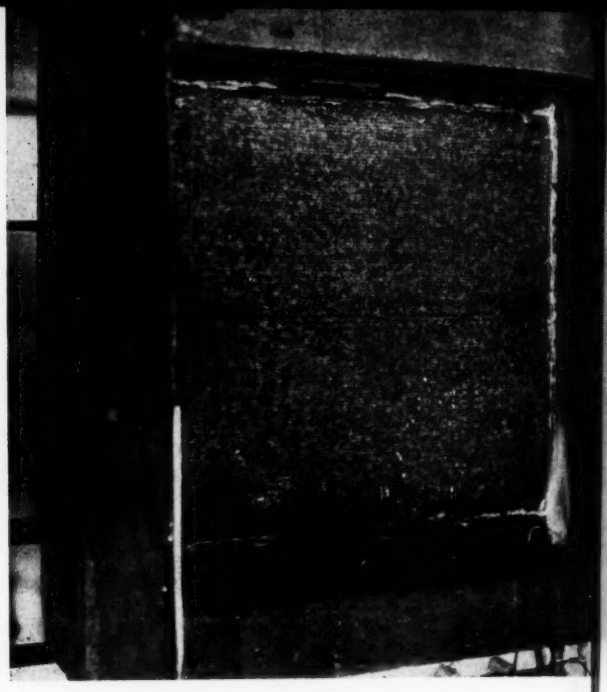


Fig. 1.
Radiant panel and pilot flame

By J. H. McGUIRE*

A Radiant Panel Igniter

ONE of the pieces of apparatus that is frequently used by the Fire Section of the Division of Building Research is the one-foot-square, gas-fired radiant panel illustrated in Fig. 1. It is the source of radiation with which, firstly, the Section's field and laboratory radiometers are calibrated and, secondly, measurements are made of the intensities that will ignite various materials. It also constitutes the essential component of the small-scale spread of flame test apparatus specified in British Standard No. 476: 1953.

It requires both a gas and an air supply and to ignite it manually is an operation in which some considerable care must be exercised. The igniting arrangements described in this note make the operation of the panel easier and safer without substantial expenditure of time and money.

Circuit Arrangement

The circuit diagram is shown in Fig. 2. For convenience it may be considered divided into three portions, the igniting circuit (top right), the pilot flame-sensing circuit (bottom right), and the solenoid valve switching circuit (to the left of the flame-sensing circuit).

For normal operation switches S_2 and S_4 are left closed and S_3 is turned to "automatic". When the main switch S_1 is closed, power is applied to the pilot gas solenoid valve and to the igniting circuit. The latter consists of an automobile ignition coil, the circuit of which is broken about four times a second by relay A. The output of the ignition coil ignites the pilot gas to give a pilot flame at the bottom right-hand corner of the radiant panel (Fig. 1). When the pilot flame is ignited the transfer of ions across the ionisation gap triggers the cold cathode triode and hence operates relay B. The source potential for the triggering electrode of the cold cathode triode is d.c.; that for the anode is a.c. with a superposed d.c. equal to the peak value of the a.c. This arrangement was the most convenient that could be devised with a view to ensuring that the cold cathode triode would extinguish in the event of flame failure.

Relay B is a sensitive device and its only function is to operate relay C. The latter disconnects the igniting circuit and operates the solenoids turning on the main gas and air.

To check the functioning of the whole arrangement a push-button circuit breaker is included in the supply to the pilot gas solenoid valve. When this supply is cut off the cold cathode triode extinguishes, hence relay C drops off, the main gas and air valves are closed and the igniter circuit is re-energised. Switches S_2 and S_4 and the "on" position of switch S_3 are incorporated to allow by-passing of the pilot flame-failure circuit and operation of the furnace without a pilot. No such requirement is foreseen in the immediate future and in fact precautions have been taken to prevent casual operation of S_3 which could switch on the main gas prior to the presence of a pilot flame.

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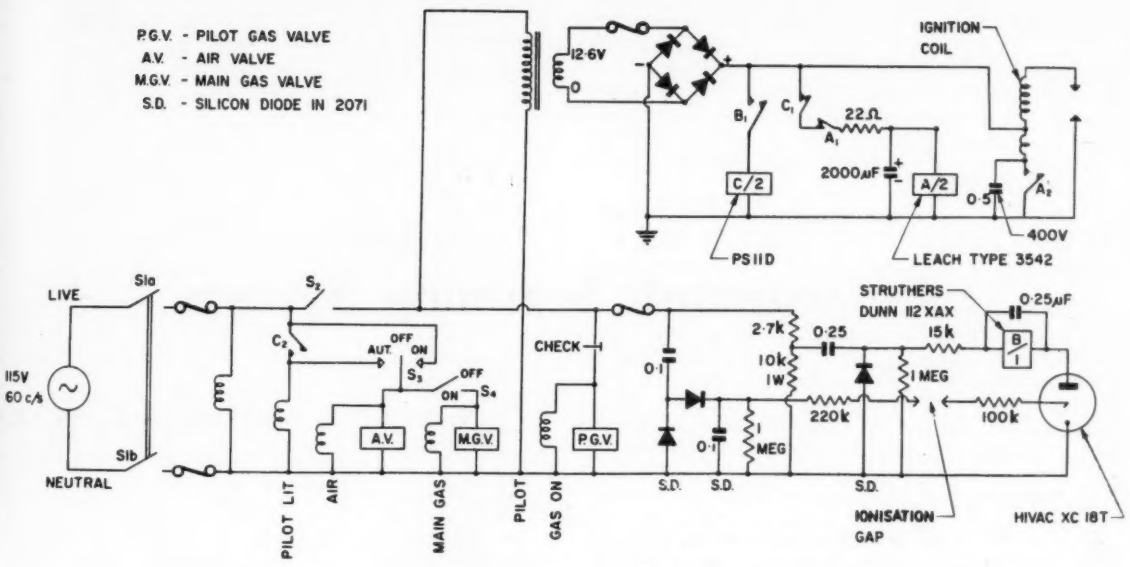


Fig. 2. Circuit of radiant panel igniter. In the solenoid valve switching circuit signal lamps are shown in parallel with the solenoid valves, and also to indicate when the pilot is lit and when the main supply is switched on.

Reliability of the Equipment

The reliability of equipment of the type described above almost invariably hinges on the safe operation of the flame-failure circuit. In this respect the arrangement described is quite good. It has been designed on a fail-safe basis and in the event of the failure of a power supply or of a relay the main gas valve will not open. The only harmful failure involving the cold cathode triode would be a short from anode to cathode and the likelihood of this is remote.

An occurrence that must be guarded against is a short between the two wires constituting the ionisation gap. This is probably the worst fault that could possibly develop for it could allow the switching on of the main gas supply without the presence of an igniting source. Two steps have been taken with a view to eliminating this. Firstly, the connections to the gap are made with earthed screened leads so that in the event of breakdown of the insulation the cold cathode triode cannot fire. It was found that there is a limitation to the length of the screened lead which can be connected to the triggering electrode, corresponding to an increase in the associated capacity to a value of about 0·002 μF. It appears that the ion current in the triggering circuit, with the potential source described, is not sufficient to ensure that the triggering gap remains continuously fired. The circuit therefore behaves as a resistance capacity relaxation oscillator. Fortunately such an oscillatory discharge is as effective as a continuous discharge if the frequency is high compared with the 60 c/s imposed on the anode of the triode. If a substantial length of screened lead had been required it would have been necessary to eliminate the effect altogether by using a higher potential source. This could be conveniently derived by adding another stage to the rectifier circuit so that it constitutes a Cockroft-Walton generator.

The second measure helping to obviate a short between the ionisation gap wires is to have a physical arrangement which makes it unlikely that they will touch. The most convenient way of ensuring this is usually to bring the two wires in from opposite sides of the flame. Close to the gap the wires pass through a 2-inch thickness of concrete which could develop fairly high temperatures. Some care was necessary here since it was found that high temperatures sufficiently reduced the resistivity of most insulating materials to trigger the cold cathode triode. Thus it was even found that ceramic beads, when heated, did not provide adequate insulation between the two ionisation gap leads. The minimum value of resistance which will trigger the triode is of the order 10^7 to 10^8 ohms. The problem was overcome by leaving a clearance around the wires and ensuring that the bulk of the concrete was connected to an earth potential point so that in the event of contact between the wires and the concrete the cold cathode triode would fail to fire.

Conclusion

The arrangements described greatly facilitate the ignition of a radiant panel and provide several safety features at low cost.

Acknowledgements

This is a contribution from the Division of Building Research, National Research Council, Canada, and is published with the approval of the Director of the Division.

Polarograph Scanning System

By HUGH C. McINTYRE, M.A., M.C.I.C.*

A LARGE Canadian mining and smelting company recently introduced automatic polarographic analysis in its ore-reduction plant. (See Electrochemical Means for Rapid Analysis of Metals, *Instrument Practice*, July, 1961, page 865.) A programme for improving process control and plant economy required continuous monitoring of approximately one hundred points in various flow streams for concentration of three metallic sulphides and several inorganic reagents.

Many of the points to be monitored required analysis for several components; that is, the nature of the sulphides and reagents to be tested varied from one monitoring point to the other. For example, point No. 1 might require analysis for X sulphide, Y sulphide and reagents Z and R, while point No. 2 might require analysis for X sulphide, A sulphide and reagents S and U.

Although the time constants of the process were fairly long, an analysis of process dynamics indicated that each monitoring point should be interrogated at ten minute intervals and that off-limit conditions should be alarmed and printed out within ten minutes of occurring. In addition, one complete set of analysis values had to be printed out each hour to provide an empirical basis for constructing a mathematical model to be used in further improving process technology.

Finally, although this system was primarily intended for process monitoring, it should be ultimately capable of utilisation as a control system for the entire operation, in conjunction with temperature and flow measurement and control equipment plus a computer. It was, therefore, necessary that the system be sufficiently flexible to allow variation of the off-limit settings either manually or automatically.

It was obvious from these requirements that a highly sophisticated system for obtaining, handling, and reducing data would be necessary, so the company contacted Designeering Ltd., a Canadian design and consulting company who specialises in the leasing of integrated engineering design teams. The problem was tackled by the Systems and Control Group of this organisation, headed by H. A. Stein, P.Eng., an interdisciplinary team of consultants who address themselves to a wide range of industrial and commercial studies using the operations research approach. After considerable study, they made a proposal to the company for the solution of the problem by means of the electronic system described here.

Why Polarography was Chosen

The first question considered was the selection of the analytical apparatus. Considering the basic chemistry involved in analysing samples from the process, and the company's own experience with such equipment, it was apparent that the best instrument would be the polarographic analyser.

This choice was a compromise between a number of factors such as accuracy, speed of operation, ease of sampling, reliability, availability of components, and cost of installation and operation. Other instruments such as the infra-red or X-ray fluorescent spectrometer would have also been suitable for the task, but one or more of the foregoing factors militated against its selection.

A refinement, which permits the polarographic potentials to be spread (so that voltage resolution is not critical), consists of adding complexing agents to the sample being analysed.

Decisions as to which complexing agent is most suitable may be augmented by the use of thermodynamic data. Among the complexing agents which were considered were the versenes and the complexones which have been used for some time in polarographic work, and diorthohydroxyazo dyes.

Sensing and Sampling Unit

Functionally the system is divided into two units: a sensing and sampling unit; and a control and printout unit.

Each location at which analysis is required will be

*Technical Editor, *Canadian Chemical Processing*.

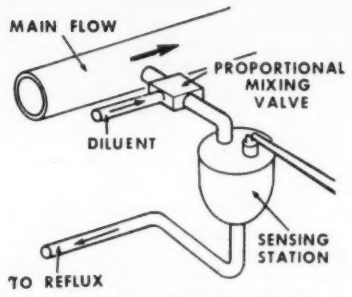


Fig. 1. Sampling point with its pipelines, sensing and sampling unit

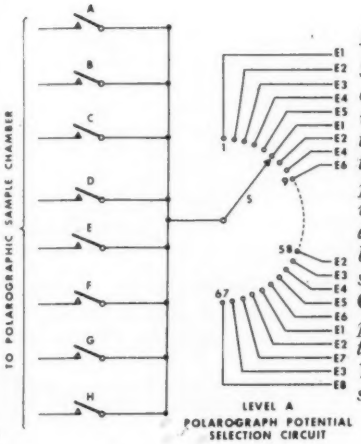


Fig. 2(a). Selection circuit controlling type of ion analysed. In this example one of the eight half-wave potentials characteristic of the ion to be determined is selected by each step of the switch S. There are 67 switching stations programmed into the circuit (stations 10 to 57 are not shown).

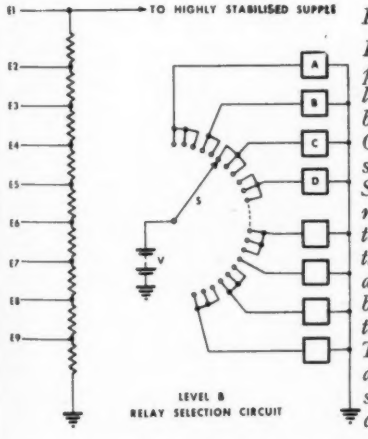


Fig. 2(b). Relay selector programmed for locating sample to be analysed. A, B, C, etc., are separate sampling stations. Switch S selects the next sensing station to be read out after the prescribed analysis cycle has been completed at the last station. There are approximately 100 stations in the circuit.

equipped with a sensing and sampling unit. Fig. 1 shows a sampling location with its pipelines.

A flow from each pipe passes continuously through the sampling chamber. In addition, a diluent containing a complexing agent is continuously injected. The proportions in which the diluent and the substance to be analysed are mixed is controlled manually by a proportional mixing valve. Following analysis, the contents of the sampling chamber is discharged into a reflux line.

Contained within each sampling chamber is a set of rotating and vibrating platinum micro electrodes, enclosed in an ion-permeable sheath. The complex motion executed by each electrode is maintained by a small motor and cam assembly.

Control and Print-out Unit

The control and print-out equipment operates synchronously, the synchronisation being provided by a pulse-emitting electric clock.

Each pulse from the clock is applied to a programmed half-wave potential unit and a station selection unit. These units are represented as stepping switches in Figs. 2 (a) and (b) (levels A and B). At the first positions of the switch (initiated by the first pulse from the clock), relay A is energised. This causes the contacts of relay A to close (in series with the " polarograph potential " selection switch) thus placing potential E across sensing and sampling chamber A. Potential E is the polarographic half-wave potential, characteristic of the first ion (ion 1) for which analysis is being carried out at station A. Application of potential E across the chamber causes a current to flow, the magnitude of which is proportional to the concentration of ion 1 in the sample. This current is then fed to the OR circuit No. 1 (Fig. 3). The next pulse from the timing clock causes the relay selection circuit to step to the next position. As the diagram indicates, relay A remains closed (level B) but potential E_2 is placed across the sampling chamber (level A). Potential E_2 is the polarographic half-wave potential characteristic of the second ion (ion 2) for which sampling station A is being examined. The application of this potential causes a current flow which is proportional to the concentration of ion 2 in the sample. This current is then fed to OR circuit No. 1. Upon application of the next pulse from the clock, potential E_3 is fed through the stepping switch to sensing and sampling unit A (relay A still energised). A current proportional to the concentration of ion 3 is then fed to the same OR circuit mentioned above.

The next pulse from the clock removes relay A from the circuit; relay B is then actuated, thus allowing sampling voltages to be placed across sensing and sampling unit No. 2. At each of these two switch positions potentials E_4 and E_5 respectively are applied to station B, resulting in currents proportional to ions 4 and 5 entering OR circuit No. 1.

Scaling Amplifier Equalises Current

Succeeding positions of the stepping switches energise each relay in sequence, permitting polarographic potentials to be applied as programmed previously. The current signals generated by the concentrations of the various ions in the solution are entered sequentially into the scaling amplifier which is controlled by the programme control unit.

Through this arrangement, resistors are switched into the circuit, resulting in the current being either multiplied or divided by a factor to bring the output of the amplifier to a level which can be used as an input for the associated units.

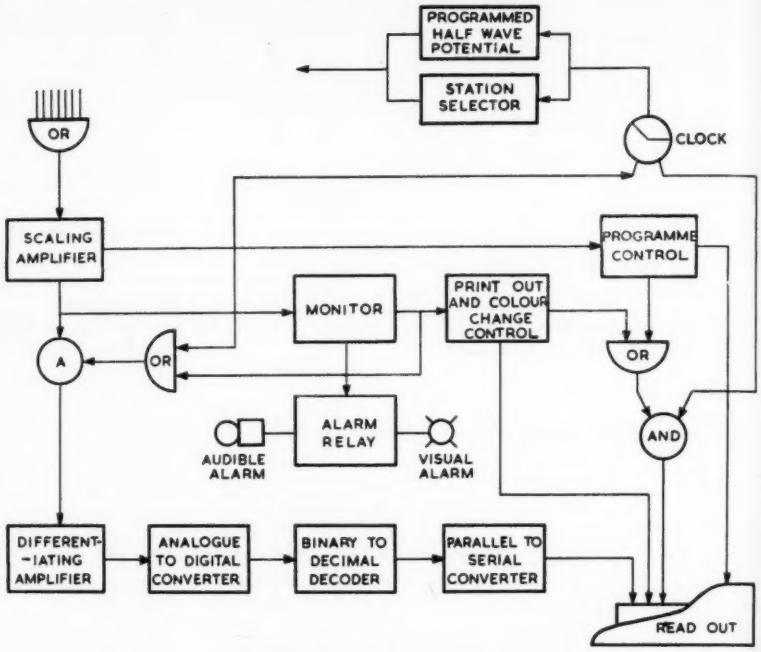


Fig. 3. Control and print-out circuit. The level A and B circuits are shown by the two blocks at the top of the diagram, their output going to the sensing stations. Input from the sensing stations goes through OR gate No. 1 to the scaling amplifier. The monitor unit detects off-limit conditions and feeds a signal to OR circuit No. 2 and thence to AND circuit No. 1 (marked A in the diagram). OR circuit No. 3 and AND circuit No. 2 are seen immediately under the programme control block.

Off-limit Signal Gives Alarm

At this point three alternative actions are available depending on whether an off-limit condition has occurred, an hourly read-out is required, or whether a combination of these conditions exists. Let us assume that an off-limit condition occurs at some time during an hourly scan. The output of the scaling amplifier is applied to the monitor in which the high level set points for each ion have been pre-set. These pre-set points are determined by potentiometer settings, thus providing an output signal proportional to the setting. The scaling amplifier signal and the pre-set monitor signal are fed to a comparator circuit. If the output of the comparator circuit is above or below the tolerance limits, a colour change signal is fed to the read-out device (via the print-out and colour change control) causing the printed record to appear in red. In addition audible and visual alarm signals are energised by an alarm relay.

Making Output Available for Read-out

The output of the monitor then passes through OR circuit No. 2 to AND circuit No. 1. This signal plus the output from the scaling amplifier operates the AND circuit, permitting the scaling amplifier output to be fed to the differentiating amplifier. Pulses, the height of which are proportional to the concentration of the ion in the solution, are then produced and fed to the analogue-to-digital converter where a digital signal representative of the pulse height is produced. This binary output is then applied to the binary-to-decimal converter and then to the parallel-to-serial converter. The output of this unit is then available for the read-out device. However, print-out cannot occur until a control signal is sent to the read-out unit.

Where Read-out Signal Comes From

This signal may originate from two locations. A signal from the programme control to the read-out unit could initiate this action if the carriage were properly positioned and no other print-out signal originating in the print-out control unit would pass through OR circuit No. 3 to AND circuit No. 2. When a timing signal from the clock was applied to this AND circuit, the circuit would pass the print-out signal on to the read-out unit. At this point the off-limit reading would be printed. Adjacent to the off-limit reading, the time of the deviation would also be printed. Elapsed time from detection of off-limit condition to print-out is of the order of one second.

During the hourly print-out of all analysis values a signal from the clock is applied to AND circuits Nos. 1 and 2 rather than signals from the monitor unit. The result is similar to that described above for the off-limit condition. Analysis values from the scaling amplifier pass through the amplifier and converter units to the read-out unit and the print-out signal from AND circuit No. 2 permitting the analysis values to be printed on the read-out unit.

The programme control unit ensures that the sequence of time and the analysis print-out procedures do not interfere with each other. In addition, this unit ensures that movements of the read-out carriage are co-ordinated with the information print-out.

Varied Application Possible

The system described above may be used with any combination of diluents and complexing agents as long as the half-wave potential of each required ion is accurately known. Applications in organic analysis are also possibilities, where pharmaceutical and biochemical analytic problems are dealt with.

Report on the

Third International Convention on Analogue Computation Opatija, September, 1961

By Dr. C. M. CUNDALL Head of the Control Project Group
Automatic Control Division
Ferranti Ltd.

250 DELEGATES representing 26 nations met for the Third International Convention on Analogue Computation at Opatija, on the Adriatic Coast of Yugoslavia, whence the venue had been moved to make way for the Uncommitted Nations in Belgrade.

The convention opened with a short address by the President of A.I.C.A.*, which was followed by reviews of the state of the art given by leading exponents of analogue computation. Although given by people of widely different interests and nationalities, these reviews all pleaded for the same things.

1. That from the viewpoint of the designer who is making use of a computer, he should make a " system approach " in which all aspects of the problem are brought to bear on the solution and
2. That in providing equipment to solve the set of equations which this approach yields, there should be a much closer integration of the techniques of analogue and digital computation. The latter in particular was a recurring theme throughout the convention. These comments were taken to apply to computers used as elements of complex closed-loop control systems as well as to computers used for solving scientific calculations.

Exactly 100 papers covering both the design and users aspects were on the programme of the technical sessions which took up the remainder of the convention. The conspicuous feature of these was the fact that some topics (e.g. nuclear problems) were the subject of large numbers of papers whilst other important topics (e.g. digital differential analysers) were completely absent.

Computing Methods—Accent of Hybrid Systems

There was little new to be heard about purely analogue computing methods which have by now become fairly well established. What papers there were in this category covered techniques for function generation, two new methods of multiplication, a triangular wave multiplier, a cheap version of which is suitable for process control applications, and a sampling electronic multiplier, and finally the transistorisation of analogue computers.

Hybrid computing methods received considerable attention. Most papers discussed digital computing elements which could be added to conventional analogue computers to cater for increased accuracy requirements or to perform operations like pure time delays or integration with respect to a variable other than time, which cannot conveniently be performed with analogue equipment.

One paper showed how a special digital control computer has been connected to an analogue computer to satisfy the same needs.

A quartet of papers described how the integrated data processing of results from missile firings are carried out at W.R.E., Australia, using combined analogue and digital systems. Finally, some papers showed how automatic programming techniques can be applied to analogue computers to try and achieve some of the flexibility normally associated with digital computers.

The largest number of papers dealing with hybrid computers came from Japan, but most of them were not presented.

Computer Applications — Accent on Nuclear Systems

Solutions of field problems was a general category covering 20% of the papers and over half these were presented in French. Some of them dealt with particle trajectory calculations, some with structure problems and others with problems occurring with the design of nuclear reactors.

The papers in the session on nuclear reactor systems dealt with analogue computer work on reactor dynamics, on reactor control and stability and on reactor simulators for training purposes.

The other computer applications dealt with fell under the broad headings of power systems, control systems and biological systems. Japan had a monopoly over the first of these in which hybrid systems were described for use in economic load dispatching and power system stability calculations. One of the most significant papers in the control systems section described a method for process parameter estimation using an analogue model.

Concluding Comments

It has long been my contention that the biases and prejudices of designers and users of analogue computers and digital computers for their respective methods need to be removed, and this convention has clearly indicated that one "A" must soon be omitted from A.I.C.A. In the meantime this was an interesting convention, well organised from an administrative viewpoint by the Yugoslavia Committee for ETAN, but there must be one major criticism. That only abstracts and not complete papers were available at, or preferably before, the convention. Their absence much reduced the value to be gained from the technical sessions and reduced the discussions to practically zero. My final remarks I address to presenters of papers at conventions of this type: please omit detail and concentrate on general principles. And, secondly, to session chairmen: please prepare some remarks to stimulate discussion.

*International Association for Analogue Computation.

INSTRUMENTATION IN CHOCOLATE MANUFACTURE

By R. D. HOSKIN,
A.M.I.Mech.E., A.M.I.E.E., A.M.Inst.F.*

Part 3. The Development of Confectionery Production Machinery

THE manufacture of confectionery involves three basic operations: the preparation of raw materials, their moulding into the final product, and finally packing each unit into a wrapper that is not only attractive in appearance, but functional in its design.

This article endeavours to outline some of the progress that has been made in the development of well established lines which were originally made by batch processes, and which are now produced in very large quantities on automatic plant.

With the great diversity of lines that are available, it would not be possible, or practicable, to describe in detail the many changes that have taken place, it is, therefore, intended to take just one of the many units produced at Somerdale, Fry's chocolate cream bar, as an example, and to trace the development of this particular line through its history.

In its original form the bar was produced by hand methods, the output being sufficiently low, and labour and material costs being sufficiently cheap to preclude any other method.

The centres were first prepared using cornflour moulds, the cream being poured by hand into the moulds, and these were left to cool in large rooms which were slate lined. After demoulding, the centres were then dipped in liquid chocolate and then allowed to cool once more. From start to finish the process was completely uncontrolled, the whole operation being left to the skill of the production operator, who could maintain a reasonably consistent quality of product as long as the output did not become excessive.

Continuous Cream Cooking

As outputs increased, it became necessary to devise methods that would ensure more rapid production and, at the same time, maintain or improve the control of quality, and one of the first innovations that helped to attain this was the development of continuous cream cooking. The cream used for the basis of this line was originally prepared in batches, cooked at a predetermined temperature and then poured as required.

In a continuous cooker, the glucose is fed by pump into the inlet—steam is applied to an outer jacket, and the temperature of the cream at the outlet is measured by thermometer.

This method has many advantages over the batch process, but it is subject to a number of difficulties. In the first place, the amount of glucose being cooked at any one time is small in relation to the quantity of steam available; this means that there is a much greater risk in this method of cooking of overheating the syrup and, consequently, spoiling the work. Secondly, any variation in the pump delivery can seriously affect the end product, for the same reason. Finally, any changes in throughput or steam conditions take place fairly rapidly and must be corrected by the operator instantly, if waste is to be avoided.

For a number of years the control of cooker output conditions was arranged by the operator, by adjusting weights on a reducing valve inserted in the steam line to the cooker, thus varying the steam flow.

The modern glucose cooker manufactured by Messrs. Baker Perkins is shown in Fig. 1. This machine relates the throughput of syrup to the output temperature. The steam supply to the cooker is controlled by a modulating valve with valve positioner, operating from a controller, which in turn receives a signal from a temperature sensing element inserted in the outlet

*Power Services Engineer, J. S. Fry and Sons Ltd., Bristol.

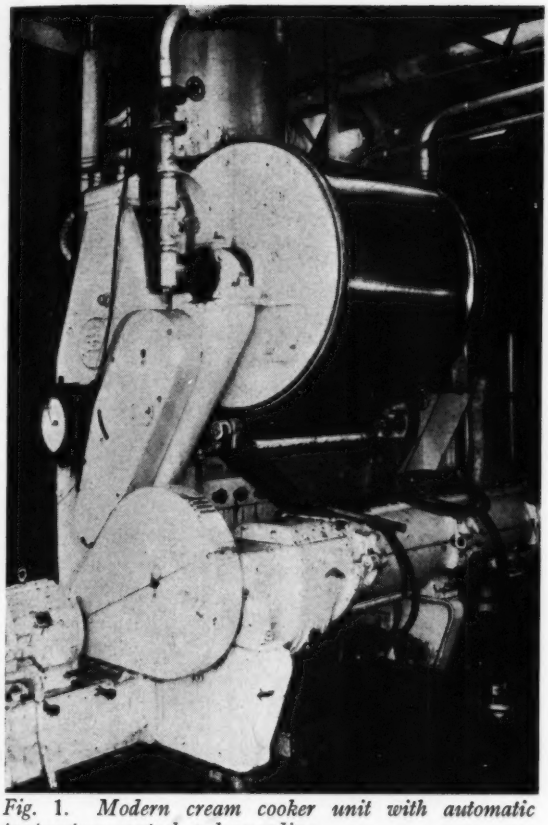


Fig. 1. Modern cream cooker unit with automatic temperature control and recording

from the cooker. For the majority of applications simple proportional control is sufficient, and this simplifies the installation, and helps to keep cost to a minimum.

Continuous Moulding Plant

For some time, this simple innovation was sufficient to maintain the high outputs from cookers, with the minimum of waste, but gradually the demand increased still further, and a complete change in the manufacturing technique was necessary, if outputs were to be increased radically. This was achieved by the transition from batch production methods, using mechanised moulding and enrobing, to continuous moulding plants, operating at high speeds and producing very large outputs.

These machines still employ the earlier techniques learnt during the batch production era, but the ingredients after cooking in the automatic cookers are then pumped or conveyed to the continuous moulding plant, and output is then maintained throughout the shifts.

The block diagram, Fig. 2, gives the basic problems involved in any continuous production process, these involve the preparation of the raw materials, including continuous feeding and blending where required by the recipe.

This is then followed by the control of the ingredients into the machine using depositors that will regulate the weight of the deposit to within very close limits.

A typical depositor for chocolate moulding plants (Fig. 3) will enable the operator to maintain weights within $\frac{1}{2}$ dram or $\frac{1}{32}$ oz. Depositing cannot only involve ingredients that are easily handled in the liquid or semi-liquid state, but also extremely difficult materials, such as nuts, which can be of varying size and irregular shape.

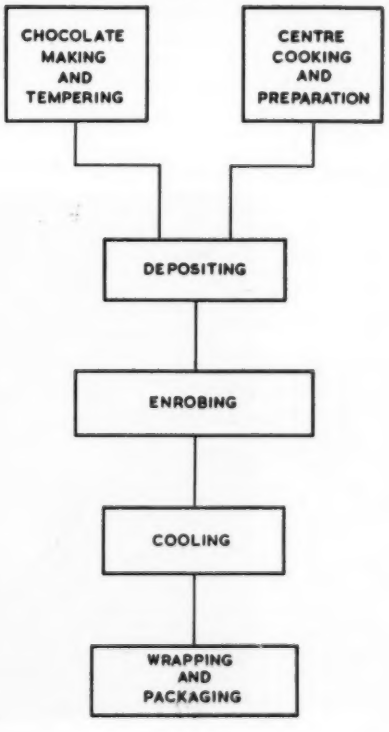
The deposit must also be synchronised with the moulds travelling underneath it. This is generally arranged by a linkage and tensioning device which momentarily stops the mould travel, under the depositor, by moving the chain conveyor sprockets adjacent to the depositor in a reciprocating motion, on guides provided for that purpose. This linkage is motivated by compressed air, which in turn is synchronised with the chain travel.

Control of Cooling

Having made the deposit, the next step in the sequence of control is the cooling of the ingredients. This is by no means as simple as it might at first appear, particularly in the case of plants manufacturing units having a high proportion of " cream " to chocolate.

The temperature at which deposits of " cream " are made is very much higher than that of the melting point of the chocolate, into which it is being poured,

Fig. 2. Flow diagram showing typical confectionery production process layout



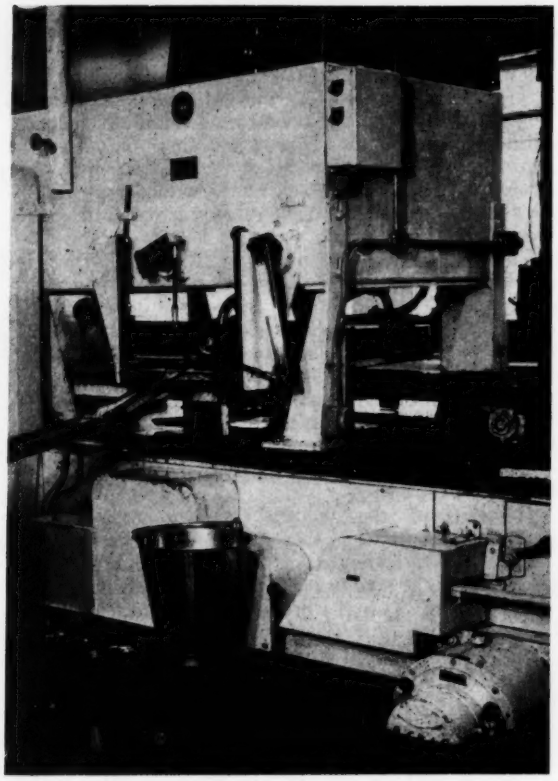


Fig. 3. View showing cream depositor and synchronising gear

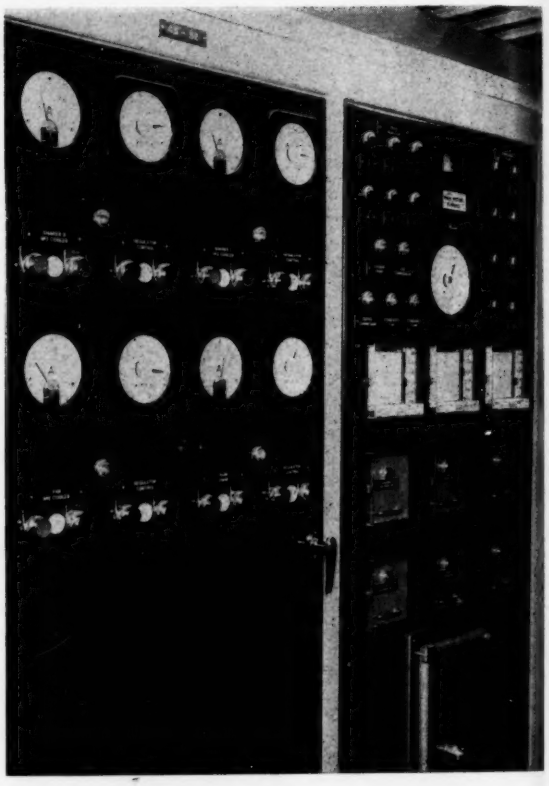
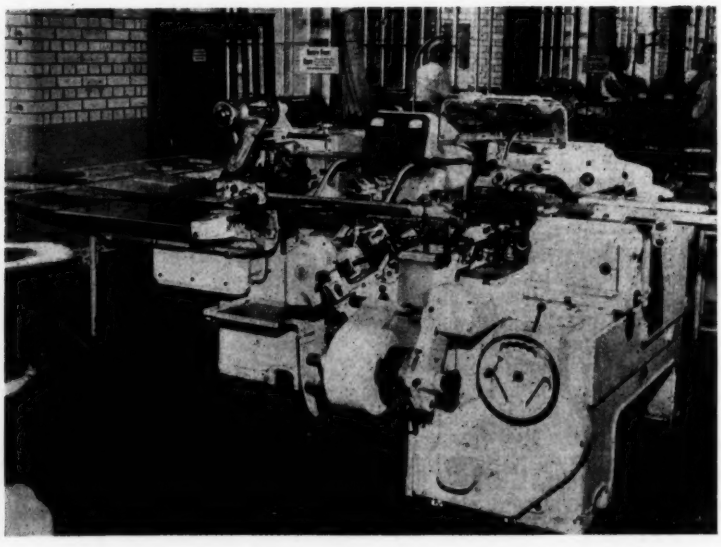


Fig. 4. Part of control panel showing recording thermometers and control equipment

Fig. 5. Wrapping machine



and there are two basic problems involved. In the first place, it is necessary to remove the heat from the " cream " in order that normal crystallisation can take place of the sugars in its composition. At the same time, the heat must be removed sufficiently rapidly to prevent the " burning " of the chocolate into which it is being poured. This means that the cooling must be very rapid, if it is to be effective, and the temperature of the air supplied to the cooler is usually very much lower than that normally required for orthodox chocolate machinery. The chocolate/cream ratio is a critical factor in establishing this cooling temperature, and it will vary depending on the unit being produced. In general, the larger the chocolate/cream ratio, the less cooling is required, but other factors, such as the speed of the machine and the air quantity, are also of great importance.

The control of air temperatures entering the moulding machine has to be critical, and on a number of installations the type of control is that described in the second article of this series on Automatic Stockrooms, manufactured by the Watford Electric & Mnfg. Co. Ltd.

In a moulding machine of the type under discussion, at least three separate sections are involved, each having its own control of air temperature, and in the case of cooling below freezing point, some form of defrosting is required, or alternatively, means to prevent the build-up of ice on the coils. This is sometimes arranged using pre-cooling, the air temperature being lowered initially to a temperature just above freezing, and a large percentage of the moisture is then removed as condensate. This enables production to be maintained during shifts continuously, with a small period for " defrost " between them.

Fig. 4 shows a typical control panel for one such machine, housing the starting equipment for some of the drivers, and also the temperature recording apparatus, and control gear.

Wrapping

After " demoulding ", which involves a synchronised ejection device, the units are fed into wrapping machines (Fig. 5).

Unless exact synchronisation of the paper wrapper is achieved, the unit will not be covered correctly, and rejected work will result. To control this adequately, a photo-electric cell is employed, operating a delay unit attached to the spool feed on the machine. If a special mark printed on the paper is in line with the photocell, the feed into the machine is allowed to continue. If, on the other hand, it is found to be out of place, an impulse to the delay mechanism results in a momentary interruption of the feed, and the paper once more comes back into synchronisation.

In practice, this means that the spool feed is always allowed to run at slightly more than synchronous speed, in order that the delay mechanism might control the unit positively.

Next month, we will conclude this series of articles by describing in more detail some of the problems encountered in the preparation of the main ingredient of all lines—chocolate.

(To be continued)

Volunteers Wanted

THE NUFFIELD TALKING BOOK LIBRARY for the Blind is fortunate in having some fifteen volunteers servicing the Talking Book machines used by their members throughout the country. Unfortunately there are many areas where no volunteer is available, and with an expanding Library service the need for more is very great.

The equipment provided consists of a record player modified for easy operation by a blind person, or a simple reproducing machine for tape recordings housed in a specially designed cassette.

Volunteers would be called upon to install machines in members' homes, ensuring that the machine is operated in accordance with the instructions, and so enabling the user to derive the utmost enjoyment from the recordings provided; also to service or repair machines when faults develop. No financial obligation is involved in undertaking this service, and any spare parts required are supplied direct from the Library. The components used are of the standard type. The degree of help given would be governed by the volunteer's knowledge, and by his willingness to proceed with his task, but usually quite simple repairs are involved, such as the replacement of a volume control, or a valve. Circuit diagrams, guidance notes and technical data will be provided. In general, the time required does not exceed one evening's work in almost two months.

Volunteers are from every branch of the electronic or radio trade or profession; anyone who is prepared to help in this valuable and worthwhile work should write in the first instance to:

Mr. D. Finlay-Maxwell, A.M.I.E.E.,
Hon. Organiser of Servicing Volunteers,
c/o Messrs John Gladstone & Co. Ltd.,
Galashiels, Scotland,

indicating the approximate area that could be covered.

Diamonds in Industry : An Introduction

THIS booklet, which has been published by the Industrial Diamond Information Bureau, has been prepared to meet the needs of students and engineers who require basic information about the varied uses of industrial diamonds. The booklet begins with a brief introduction on the formation of diamonds under intense heat and pressure; on the historical uses of diamonds; and on the selling organisation through which they are distributed. Following this, the hardness of diamond and the exploitation of this property throughout the whole range of industrial applications is described. In each case the appropriate type of diamond material for the job is described, from the lowest, known as " boart ", which is crushed for use in grinding, to the highest quality stones used in lathe tools.

The booklet concludes with an account of new uses of diamonds which depend on properties other than its hardness. The semiconducting properties of Type IIb diamonds, together with a combination of other properties, make them an excellent thermistor material; diamonds are also used as radiation detectors in nuclear research, and as transistors in radio receivers.

A Report on

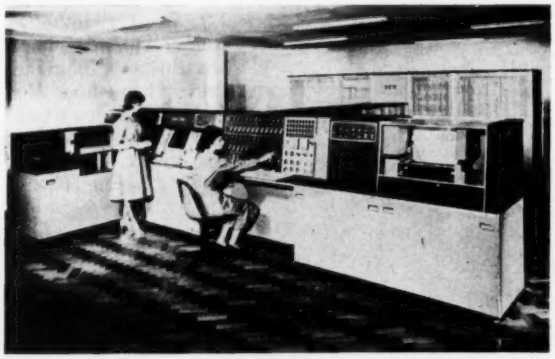
The Electronic Computer Exhibition & Symposium

Introduction

THE Electronic Computer Exhibition was opened officially by Lord Brabazon of Tara. In his speech Lord Brabazon drew attention to the slowness of this country in applying new developments. Examples of this can be seen in many fields and in the computer field in particular there are more manufacturers in this country than the rest of the world put together, yet in Britain there are about 350 computers actually installed and working, while on the continent of Europe there are said to be about 1,000 computers installed and working. A tool that is not used properly might as well never have been invented and it is up to British business to work out new uses for computers and apply them so that they can use this tool to meet competition. It is also up to computer manufacturers to make sure that prospective clients appreciate its potentialities by studying what their problems are and showing how a computer can help.

The placards advertising this exhibition said " see the new generation computer ". A fine phrase, but what does it mean?

I asked a number of the exhibitors showing new equipment what their definition of the phrase was. The general opinion seemed to be that we are now in the third generation of computers and characteristics of these computers were that they used solid state components, featured time-sharing facilities and parity checking and offered higher speed, greater accuracy and a much higher standard in the components used than previously. Of course this does not represent the end as far as advance in the field of computers is concerned. What will be the features of the fourth generation? According to Dr. J. M. M. Pinkerton, of Leo Computers, the fourth generation computers will probably appear in five or ten years' time, and one of their distinguishing characteristics will be that they will be able to take instruction in a much simpler form than is now possible. At the present time we have computer instruction languages such as Cobol, Algol, Fortran, Cleo, etc. The next step forward will be computers which can take instructions in ordinary language, the only proviso being that instructions must be completely unambiguous!



The I.C.T. 1301 *electronic data processing system*

The New Computers

Data Processors

I.C.T. were showing their new 1301 electronic data processing system which was first specified in 1957. The basic machine processes information from punched cards at 600 cards per minute, and has a high speed (600 lines per minute) printed output. It is completely transistorised, operating at 1 Mc/s. The basic unit can be expanded on site, increasing the immediate access store from 400 to a maximum of 600 lines per minute, up to eight magnetic drum stores and up to eight magnetic tape units can be added at any time.

Two magnetic tape systems are available—the standard system ($\frac{1}{2}$ in. tape operating at 22,500 digits per second) and the high speed system (1 in. tape operating at 90,000 digits per second).

Other features of the 1301 are that it has a high duty cycle, i.e., by means of time sharing the hardware is used to maximum capacity and there is very little idle time.

The A.E.I. 1010 digital computer has been designed so that it can work with any type of new equipment which may become available in the future. It is completely transistorised and it can control as many as 32 single purpose peripheral units simultaneously, including output printers, fast magnetic tape units, paper tape readers, paper tape punches, card readers and card punches. The unit being demonstrated at the

exhibition was producing copy in various forms at the rate of 3,000 lines per minute.

The Datapac systems designed by English Electric Co. Ltd. are standard lightweight plug-in units having a certain logical function or functions essential for the build-up of any system of control or instrumentation. They are used for the logical circuits for English Electric's new computer, the KDN 2. This is a flexible small scale computer intended for industrial and general data processing and for process control. The instruction code is single address and a version of Alphacode is available for use with the system.

Leo Computers' most recently developed data processor is the Leo III, a transistorised computer with marked increase in operating speed over previous Leo models. Marginal test facilities provide for preventive maintenance in conjunction with the test routines. Parity checks on all transfers and automatic checking on inputs and outputs ensure that any faults are located immediately they occur. The magnetic core stores range in size from 1,024 words to 32,768 words and this rapid access storage can be augmented by magnetic drums each of 16,384 capacity.

A store access control unit operating according to a built-in set of priorities enables the functional units of Leo III to operate concurrently, and the computer can work on several programmes simultaneously.

Educational Computers

Short Brothers & Harland's new analogue computer has been developed to meet the requirements of universities and technical colleges and has been designed to serve as a lecture demonstration computer with the extra facility that it can be used as a laboratory machine having an accuracy of 1%. The setting up of a problem automatically displays on the computer board a visual presentation of the circuit diagram involved.

Chertsey Research & Development Laboratories of A. V. Roe & Co. Ltd. were showing an educational computer designed principally for the training of computer users. It is a low cost machine for illustrating the fundamentals of digital computing at low speed.

Computer Applications

A number of the exhibits featured computers as applied to specific applications.

Leo Computers showed the Kimball tags to paper tape converter in operation. The Kimball tag is a miniature punched and printed card for transmitting information from the outset of a transaction or process, e.g. in the garment trade. Unlike normal punched cards, the edges of the tag are not used for feeding the card through the reader, instead, large holes in the tags fit on to the feed mechanism. These are not subject to wear by handling. Information from the tags can be used for stock reports, demand forecasts, sales analyses, etc.

Panellit and the Special Computing Division of Elliotts were demonstrating the use of a 609 computer for various real-time consignments. The system included special apparatus for connecting the multiple input and output equipment made up from Minilog solid-state switching elements. In the running of a continuous manufacturing process there are a variety of routine operations with certain common requirements in relation to the measurement and inter-relation of physical quantities. Many of these quantities can be measured in terms of electrical signals which can be used as input data for a digital computer. The demonstration showed the 803 being used for scanning, giving alarms and data logging and providing information such as overall efficiencies, yields, etc., which will give a complete operational picture of a typical process plant.

Among the computer programmes demonstrated on E.M.I.'s Emidec 1100 were part of the payroll at BMC's Longbridge factory, sales invoicing for E.M.I. records and typical hire service calculations such as fixed interest yield tables and engineering calculations.

Xeronic electronic computer output printer

Peripheral Equipment

Output Printer

The "Xeronic" output printer developed and manufactured by Rank Precision Industries prints information from computers on to plain paper at a rate of 4,700 characters per second. Simultaneously it prints its own forms to contain the information, from a selection of four different designs. Development is in progress on a new machine that will select from 32 forms.

An automatic and comprehensive system of detecting and indicating printing errors is incorporated in all "Xeronic" machines.

The machine is a complete departure from conventional computer output printing methods. There are no high-speed mechanical parts. Xerography and an electronic method of character generation are used.

In the " Xeronic ", the signals from the computer are written by a beam of electrons on to a cathode ray tube screen. This visual image is then copied by xerography on to a continuously moving roll of paper.

Of the machines which will be delivered this year, one will go to Ferranti for use with a Ferranti Orion computer at the company's data processing centre; the second will go to A.E.I. Ltd. to work with an A.E.I. 1010 computer in the R.A.F. Central Accounting Unit at Hendon and the third to the Commercial Union Assurance Co. Ltd. for use with an English Electric KDP 10 computer at the new Data Processing Centre in Exeter. It will also be used with the Emidec 2400 computer which is being delivered to the Ministry of Pensions and National Insurance.

Memory Systems

The Facit ECM 64 random access tape memory is of Swedish design and is now available in this country through A.E.I. It consists of 64 magnetic tape reels located on the periphery of a rotary platter. Each reel holds approximately 29 ft 6 in. of $\frac{1}{8}$ in. magnetic tape. The platter can be rotated in either direction. When a reel is addressed, the platter swings the chosen reel to the operating position via the shortest possible route. The magnetic tape's free end is weighted. When the reel reaches the operating position, the weight falls through specially designed guides. After the falling weight has led the tape past the read-write head, a pinch roller presses it against a continually rotating capstan, which rapidly winds off the tape, sending it to the tape reservoir. Reading and writing is performed during unwinding. An external order starts the rewinding. When the weight finally reaches its starting position, the station is ready for the next operation.

Both the reel platter and the reels are normally removable, but platters with fixed reels are also available. The read-write head has eight tracks. One of these can be used to advantage for parity checking. An air gap is used and tape passes the read-write head at a controlled distance. Access time to all stored data is about 2 seconds.

A new range of magnetic storage drums was on view at Sperry's stand. The Type C range is intended for high density storage. Offering a very low cost per bit, the range has been designed to meet a wide variety of computer needs.

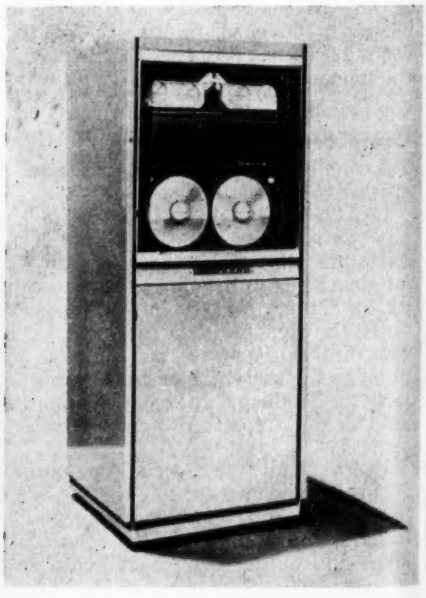
The basic C unit has 260 tracks (256 binary plus 4 wave form) offering a capacity of one million bits. Additional units may, however, be built up vertically on a common shaft driven by the basic motor of the 1C unit. Types 2C, 3C and 4C thus offer respectively twice, three times and four times original capacity. Type D is the latest and smallest addition to the Sperry range and is a miniaturised unit designed in the first instance to meet airborne and Service requirements, where compactness is vital.

With a drum diameter of 3 in. and a choice of running speeds of 6,000, 8,000 or 12,000 rev/min, these drums are equally suitable for industrial applications where lack of space and reliability are prime considerations. Decca are to employ a Type D unit as a digital computer to convert hyperbolic or other coordinates to the cartesian coordinates normally used in navigation.

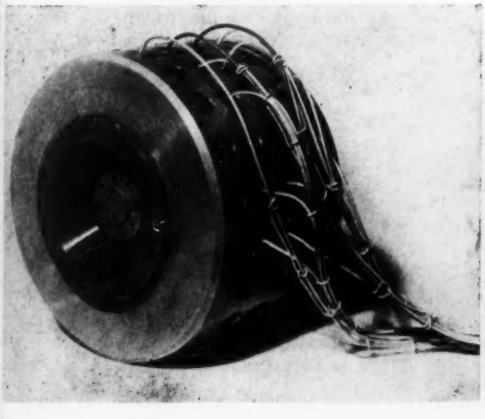
Type E drums meet a wide variety of data correlation and logging needs, particularly those of the nuclear, chemical and processing industries.

The most recent memory store available from Plessey Co. Ltd. uses tunnel diodes as storage elements and has an immediate access time of 50 mμs. It will be constructed in self-contained modules having a basic printed board containing 16 bits per word.

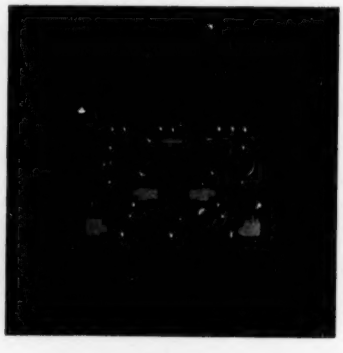
Decca Type 4000 *magnetic tape transport unit* ▶



Sperry high-speed magnetic storage drum with up to 68 *tracks giving a capacity of* 68,000 *bits*



Mullard micro-circuit (actual size) forming a complete shift register for operation of 100 *kc/s*



Other magnetic store equipment which the company is developing is a 400 million bit, random access magnetic store in which magnetic oxide coated discs are used as the storage medium.

Micro-circuits

One of the micro-circuit equipments shown by Mullard Ltd. was a multi-vibrator consisting of two transistors, three resistors and two capacitors on a substrate measuring 3 × 2 in. Another example of micro-circuitry was a complete adder comprising three 3 × 2 in. substrates, each containing four transistors, five diodes and twelve resistors. A third example showed a complete shift register for operation at 100 kc/s. It has two transistors, six diodes, ten resistors and four capaci ors on a substrate measuring 2 × 1½ cm.

Tape Transport Unit

The Decca tape transport unit Type 4000 is the latest model in their range.

The chief features of the equipment are absence of computer programme restrictions, quietness in operation, the provision of automatic loading and unloading routines, simplicity in design and operation, and the absence of maintenance adjustments. Wide margins of performance and continuous rating of components are characteristics of the design, ensuring reliability, serviceability and freedom from scheduled or unscheduled maintenance.

Two versions of the unit with similar electrical and mechanical parameters are available for handling 1 inch and ½ inch magnetic tape. The standard cabinet contains one tape transport, electronic circuits, manual control panel with logical interlocks, head amplifier circuits, and power and vacuum supplies.

Less than 2 milliseconds is required from the receipt of the start signal until the tape is running and remains running at the specified speed in correct registration with the head. At a tape speed of 150 inches per second, the length of tape lost from use during starting and stopping is less than 0·3 inches. Dual write/read heads are available at 0·39 inches spacing in order to provide for immediate check-back of recorded information. When this system is used a typical inter-block gap is only about 0·7 inches giving improved tape utilisation. Standard data rates are 45,000, 90,000 and 180,000 characters per second. The latter is achieved by an interlaced track arrangement which also leads to a very high efficiency in the usage of tape by allowing the recording of twice as much data on a reel as compared with conventional methods.

The Type 4000 design incorporates pneumatic drive of the tape. This technique permits rapid but smooth accelerations and decelerations to be achieved yet maintaining correct registration of the tape with the head. The new unit also employs large capacity bins as tape reservoirs giving ample time for smooth acceleration of the tape reel. The tape content of these reservoirs is automatically maintained between the necessary limits by a servo system employing an induction motor and saturable reactors. The tape unit is of course fully transistorised.

Symposium

Held concurrently with the exhibition was the Electronic Data Processing Symposium. This was divided into six sessions: the historical background to data processing up to the present day; data processing in industry and commerce; data processing for the smaller user; and new techniques. The papers presented were as follows:

" Progress in the Introduction of Automatic Data Processing in Government Departments ". J. D. Janes (H.M. Treasury).
" Production Control Scheme for Letchworth Factory ". J. Grant (International Computers & Tabulators Ltd.)
" Inventory Control, Accounting & Payroll ". A. Bradley (Ford Motor Co. Ltd.)
" Establishing Electronic Data Processing at the Trygg-Fylgia Insurance Companies—Stockholm ". K. E. Schang (Trygg-Fylgia Insurance Co.'s Group, Sweden).
" 3½ Years' Practical Experience ". N. C. Pollock (Stewarts & Lloyds Ltd.)
" Invoicing ". A. J. Brockbank (Glaxo Labs. Ltd.)
" Production Control by Hiring Computer Time ". R. B. Baggett (Job White & Sons Ltd.)
" Provisioning 1,300 Shops ". D. S. Greensmith (Boots Pure Drug Co. Ltd.)
" Data Processing in Commerce ". L. G. Bonney (Crosse & Blackwell Ltd.)
" Use of a Computer in Banking ". J. Letham (The Bank of Scotland).
" Using a Computer for Insurance Work ". F. C. Knight (Commercial Union Assurance Co. Ltd.)
" An Approach to Integrated Production Control ". W. J. Kease (A.E.I.—Hotpoint Ltd.)
" Commercial Planning for an Integrated Oil Company ". W. P. Brown (Shell International Petroleum Co. Ltd.)
" Recording and Controlling Production Stocks ". D. O. Bell (Standard-Triumph International Ltd.)
" Finished Stock Control, Production Monitoring, Sales, Statistics, etc." F. Stubbs (A.E.I. Ltd.)
" Production Planning ". J. Antill (Rubery, Owen & Co. Ltd.)
" Survey of the Computer Bureaux Service ". D. W. Hooper (The British Computer Society).
" Structural Stress Calculations ". Dr. C. P. Wroth (G. Maunsell & Partners).
" Costing Oil Drilling Operations ". G. De Verteuil (The Schlumberger Overseas S.A.)
" Planned Stock Control ". C. H. Bayliss (The Ever Ready Co. (Great Britain) Ltd.)
" Keeping an Inventory of Precious Metals ". S. A. Emery (Engelhard Industries Ltd.)
" Evaluation of Confidential Materials ". A. J. Stevenson (Stevenson & Howell Ltd.)
" A Market Survey ". H. Wormald (Midlands Electricity Board).
" The Place of the Programmer ". Dr. S. Gill (Ferranti Ltd.)
" Character Recognition ". Dr. M. B. Clowes and J. R. Parks (National Physical Laboratory).
" New Equipment ". Dr. A. S. Douglas (C.E.I.R. (U.K.) Ltd.)

INSTRUMENTATION IN WATER RESEARCH

Introduction

FIGURES published by the Ministry of Housing's Central Advisory Water Committee show that the margin between supply and demand will have narrowed by 1965 to a very small value. It is estimated that the gross daily demand will be 4,500 million gallons and supply will be 4,653 million gallons. These figures do not take into account demand for water for irrigation, which, in a dry season, may be as much as 240 million gallons a day by 1965.

The demand for pure water increases steadily, at a rate of about 2½% each year. Natural underground sources have reached the limit of exploitation, and the increased supplies, in the nearer future at least, will come from an increasing direct use of surface water. The conservation of our supplies is, therefore, of the utmost importance and the work of the Water Research Association becomes increasingly significant.

The Association has recently moved into new laboratories at Medmenham, Buckinghamshire, and the organisation now involves the following divisions: Chemistry, Physics, Biology, Hydrology, Plant Process, Workshop, Information and Administration. The division most interesting in the field of instrumentation covered by this journal is the Physics Division. Before dealing with this, however, it will be of interest to note briefly the main problems investigated by the other Divisions as this will indicate the scope of the laboratories.

Chemistry Division

The Chemistry Division has been largely concerned with the removal of turbidity from water supplies by coagulation. In this chemical process the fine suspended particles causing turbidity are made to coagulate into a " floc " of larger particles which are comparatively easily removed. The chemical which is added to produce this effect is termed a " coagulant ".

One of the coagulants in common use is aluminium sulphate. Investigations of the process have shown, however, that the critical factor is the pH value of the water. It has been found also that aluminium sulphate is effective only in a small range of pH values, and that unless the pH of the water is adjusted, other chemicals such as an iron salt may be far more satisfactory. By either adjusting the pH of the water, therefore, or producing by cheap methods an alternative coagulant, water undertakings may now be able to process a greater volume of water with their existing plant. Alternatively they may be able to treat the same quantity of water as hitherto at a lower cost.

Biology Division

The Biology Division has only recently been established and the first examination of the problems is now being made. It will be concerned with a wide range of subjects including aspects of water sterilisation, the speeding up of bacteriological examination and the control of algae in stored waters.

Hydrology Division

The Hydrology Division is devoting its main attention to surface waters, and its present aims are as follows:

1. To encourage the widespread improvement both in quality and quantity of hydrological measurements made by water undertakings.
2. To advise the water undertakings in membership of ways of using their own hydrological data.
3. To co-operate in the scientific study of evaporation and rainfall measurement in upland catchment areas of the British Isles.

Plant Process Division

Processes carried out on large scale water treatment plant are subject to problems which do not arise when they are performed on a laboratory scale. A water purification plant consisting of two treatment processes running in parallel and using water extracted from the Thames nearby is now being designed. It will be installed in the pilot plant laboratory and will be used for the following research:

1. To investigate existing water treatment processes.
2. To develop, from the findings of the Chemistry Division, new processes which may be applied to full scale waterworks plant.
3. To investigate particular problems which may occur in the plant of members of the Association.

The pilot plant will be large enough to ensure that processes developed in it can be transferred to full scale plant without further difficulty, but will be small enough to be flexible in operation.

Physics Division

The work of the Physics Division extends over a very wide range and necessitates development of many testing and measuring instruments.

Since the loss of water by leakage from water distribution systems in the British Isles is estimated to be at least 10% of the volume actually delivered to the consumer, the water engineer urgently needs some means of locating leaks in mains quickly and accurately. With this ultimate object in view, the Division has developed a transistorised instrument which, working in conjunction with a small magnetic device installed in a plunger (or " ferret ") used for cleaning pipes, can locate the position of the plunger inside the pipe (Fig. 1).

" Ferrets " are, generally, circular brushes or scrapers fitted on to a cylindrical body of flexible hose and are pushed along the supply line by the water pressure. If a leak occurs the " ferret " may stop and the problem is then to locate it. Any device using a steady magnetic field within an iron or steel pipe, for example, is unsatisfactory due to the screening effect. The field strength external to the pipe under such conditions may be as low as 1/100 of the earth's magnetic field. On the other hand, if the magnetic field produced by the device inside the pipe is caused to vary at a low frequency, the external field, although no greater in intensity than before, is much easier to distinguish.

The " ferret " carries a transmitter unit. This comprises briefly a transistorised flip-flop for producing pulses at a selected frequency, a power stage and a relay. The pulses operate the relay, whose contacts close and open a transmitting coil circuit. The magnetic field produced outside the pipe is detected by a unit which involves a pick-up coil whose signals are fed into a two-stage emitter follower. Next in the train is a two-stage amplifier, with another two-stage emitter follower and a 1,000 c/s oscillator. The detector is moved along the pipe until a modulated signal is heard in a pair of headphones. The volume of this signal depends on the distance between pipe and detector. At the moment the working distance is of the order of 5 ft.

A further development envisaged here is to incorporate a form of pressure switch with the " ferret " assembly sensitive to, say, 1 or 2 lb/in² which would provide information on pressure conditions within the pipe.

An alternative method developed by the Division involves the production of a rather more powerful magnetic field by means of a rotating bar magnet. This necessitates relatively large power supplies and driving motor and further research is proceeding on the design.

A totally different arrangement for leak detection consists of dosing a buried pipeline with nitrous oxide gas. This is chemically inert, non-toxic and is readily soluble in water. Should a leak be present in the pipe, the escaping water leads nitrous oxide gas into the surrounding soil and the gas may be detected, even at low concentrations, with an infra-red gas analyser.

It is desirable to establish data for the impact strength of plastic pipes since they may experience

Fig. 1. A prototype detector for a " ferret " in a buried pipeline

shock loads during their life. A testing method has been established involving a falling weight with a specially shaped plunger. The specimens, which are kept under varying temperature conditions, are placed in a V-block and the weighted plunger is allowed to fall from a given height.

Three types of result are possible. The striker may rebound, possibly leaving a slight mark but without penetrating the pipe wall. It may penetrate the wall, either completely puncturing it or at least causing the inner surface to split, the material acting in a ductile manner. It may shatter into glass-like fragments, the failure extending a long way along the pipe. Such a failure would be altogether more wasteful and expensive than a ductile puncture.

The impact strength of the pipe is therefore defined as the product of the weight of the striker and the height of the fall (that is, the energy) that will just cause 50% of a large number of specimens to fail in one way or the other.

The results show that a reduction in temperature both weakens the pipe and increases the likelihood that if it is broken it will shatter rather than puncture. At 20°C, as the energy of the impact is increased there is a well-defined level at which damage begins, and the chance of brittle fracture is small.

At 0°C damage is probable over a wider range of energy levels, and there is a fair probability of brittle fracture, causing extensive damage, at any level.

The evaluation of pressures and flows in a water distribution network can be performed mathematically, but known methods are laborious and time consuming when computation must be carried out by an operator. It is possible to reduce considerably the time involved if a digital computer is used using a programme based on the Hardy-Cross analysis method. Alternatively, an analogue computer is useful where an electrical analogue network may be set up, and the voltages and currents in the meshes correspond to pressures and flows.

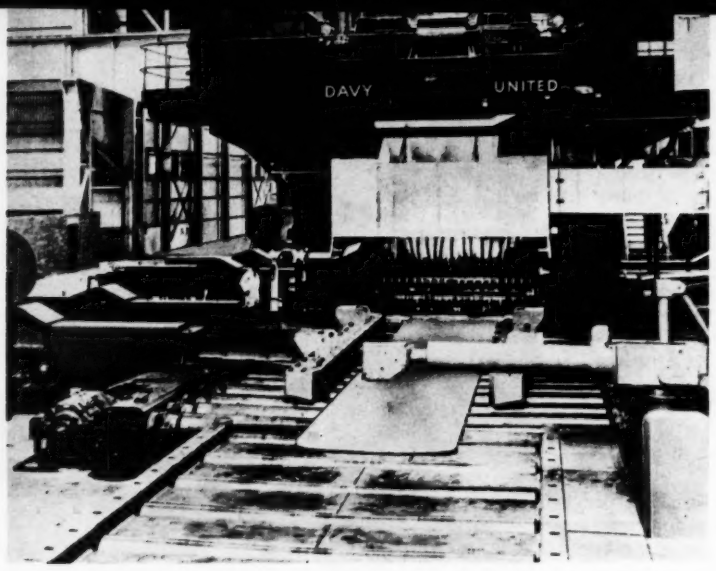


Fig. 1. This mill is designed to roll slab ingots 16 × 80 × 138 in. weighing up to approximately 8 tons, its normal duty being to produce slab 1¼ in. thick for further reduction on the hot strip line. In the foreground of the picture can be seen a gamma ray thickness gauge, supplied by Davy & United Instruments Ltd., whereby thickness of the strip and plate being rolled can be automatically and continuously measured by the use of radio-active isotopes.

Equipping The Steel Industry

THE Darnall Works in Sheffield are the headquarters of Davy and United Engineering Co. Ltd. and Davy and United Instruments Co. Ltd., both wholly owned subsidiaries of Davy Ashmore Ltd.

A visit to these works recently provided an opportunity for seeing the scope covered by the companies.

The resources of Davy and United Engineering Co. Ltd. are concentrated mainly on the building of capital equipment for the steel and non-ferrous industries. It comprises three divisions: the Machinery Division, primarily concerned with the engineering of rolling mills, forging presses and other associated machinery for the deformation of metals; the Construction Division, which undertakes contracts in any part of the world for complete steelworks, or complete departments within a steelworks, and offers an overall engineering service to any steelmaker planning a development project; and the Steel Processes Division, which engineers and supplies oxygen steelmaking plant up to complete melting shops and offers metallurgical and technical surveys to assist any company contemplating the introduction of oxy-steel processes.

Davy and United Instruments Ltd. has developed a range of instruments, both electronic and radio-active, to assist in achieving increased output from strip rolling mill plants and for obtaining better quality material.

To obtain maximum efficiency in production, the loads applied to the rolls of a rolling mill must be accurately and continuously measured. Loadmeters which incorporate a system of electrical resistance strain gauges are placed between the mill screws and roll chocks to measure this load directly and Davy and United Instruments design and manufacture loadmeters covering the range 50 to 2,500 tons/screw. From the loadmeter Davy and United Instruments have developed a range of industrial loadcells covering 200 lb to 2,500 tons which are used in a variety of applications: measuring the thrust of jet engines; weighing and controlling the contents of tanks containing up to 60 tons of corrosive acid; determining the contents of a ladle of molten metal.

Automatic gauge control is a system initially devised in the laboratories of BISRA for continuously checking the thickness of metal being rolled and keeping it at a constant thickness by automatically adjusting the load applied to the rolls and the tension of the moving strip. Davy and United Instruments, who manufacture the automatic gauge control system under licence from BISRA, have developed two alternative systems: the Gaugemeter system in which the controller derives the error signal from loadmeters and screw position transmitters, specially fitted to the mill; and the directly actuated system in which the gauge error signal is derived from the thickness gauges already fitted to the mill. The directly actuated system is simpler, less expensive, and has been developed for use on smaller mills.

Automatic gauge control has been developed by the Instrument Company to the point where gauge can be controlled consistently to within ±0·0003 in. A number of important contracts for installations of this equipment are now in progress. These include automatic gauge control and complete instrumentation for a 4-stand cold strip mill at the Gartcosh Works of Colvilles, and automatic gauge control for a 4-high cold reversing mill at the Newport Works of The Steel Co. of Wales. Over the past two years automatic gauge controllers have also been installed in Japan, and at Hüttenwerk Siegerland, Germany.

Other developments followed from the work done on automatic gauge control. To measure and indicate the actual gauge thickness a range of radio-active non-contact strip thickness gauges have been developed in collaboration with Isotope Developments Ltd., which

are built to stand up to the arduous conditions in steelworks. A thickness gauge installed for measuring the thickness of hot rolled steel plate up to 2 in. thick has an accuracy of 1% of measured thickness and indication could be of either the error or direct reading kind with a response down to one second. A beta gauge used on classification duties in a tinplate works has an accuracy of 0·00005 in. and a response time of 0·05 second.

Widthmeters based on the BISRA optical widthmeter (see *Instrument Practice*, **13** (3), March, 1959, pp. 277-282) have been developed to cover a range of strip widths from 1 to 150 in. The widthmeter installed on the 28 in. 5-stand tandem hot strip mill in Arthur Lee & Sons' works at Meadowhall can measure width of hot strip to within ±0·030 in.

The widthmeter supplied to the slabbing and plate mill of the Algoma Steel Corp. in Canada was designed to cover widths between 40 and 132 in. wide. The instrument was mounted 50 ft above the roller table of the mill in order to avoid interfering with the operation of the cranes in the shop. Its specification called for an accuracy of ±½ in. in the measurement of the overall width of the slab. On test in Davy's workshops, the accuracy achieved was approximately ±⅛ in. The instrument employed two telescope units containing photocells which were activated by the radiation from the red hot slab. The servo-operated shutter in each head moved so as to admit the same amount of radiation from one end of the slab as was being received by a second photocell viewing a constant area of the slab some distance from the end. The position of the shutter in each head provided a signal to an indicator which showed the amount by which the width of the slab deviated from the distance separating the two telescopes. The position of the telescope units themselves was transmitted to the mill control panel by means of a selsyn-counter arrangement linked to the lead screws moving the telescope units on their guide tubes.

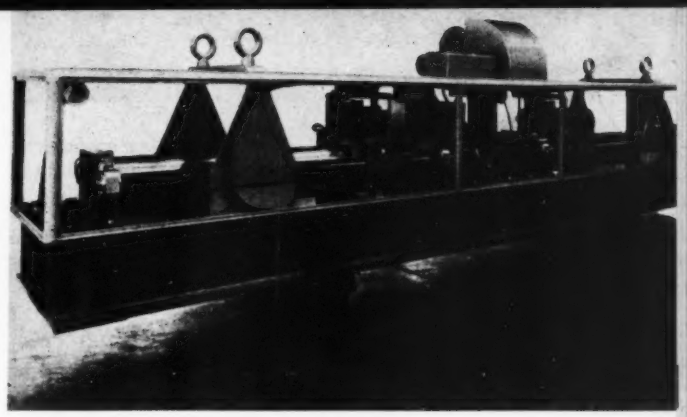


Fig. 2. Widthmeter supplied to the Algoma plate and slabbing mill, Canada

SIMA Notes

SIMA Export Forum

The second meeting of the SIMA Export Forum was held at the "Paviours Arms", Westminster, on 17th October. Just under a hundred representatives from member firms attended together with several guests from the Board of Trade, and Mr. T. H. C. Raikes, of the Western Hemisphere Export Council. Mr. J. E. C. Bailey, C.B.E., of Baird & Tatlock was in the chair and was ably assisted by a panel drawn from the Export Committee and the member firms.

It was a most enjoyable and profitable evening which covered a large number of the factors affecting trade with N. America and Canada.

Representatives on B.S.I. Industry Committees and Sub-Committees

SIMA representation on B.S.I. Committees and Sub-Committees has now been brought up to date and there is a total of 165 representatives from SIMA serving on some 117 committees and sub-committees. A new administrative procedure has recently been adopted to ensure that a smooth liaison is maintained between representatives and those members who are interested in the results of the different sub-committees and co-ordination if required is undertaken by The Technical & Standardisation Committee under the chairmanship of Mr. G. Whipple, C.B.E.

Meetings

At the last meeting of the Nucleonic Group and Section 6, Major W. Logan, of Avo Ltd., was re-elected as chairman of Section 6 for the current year and Mr. J. F. Hendrie, of EMI Electronics Ltd., was elected as chairman of the Nucleonic Group, with vice-chairman Mr. E. B. Thompson, of Ekco Electronics Ltd.

Section 1 held a meeting at the Connaught Rooms on 12th October, under the chairmanship of Mr. M. G. L. Curties, of C. Baker Instruments Ltd. Members heard a most interesting address by Dr. C. G. Wynne, the head of the design unit at Imperial College.

SIMA Delegation to Italy

The SIMA delegation to Italy left London Airport on 22nd October, after two months of intensive preparation including a preliminary visit to Italy by the Director, Captain R. A. Villiers, C.B.E., A.M.I.E.E., and Dr. F. Hamill, of Hilger & Watts Ltd.

The delegation, under the leadership of Mr. A. W. Jones, President of SIMA, includes Mr. J. E. C. Bailey, C.B.E., of Baird & Tatlock (London) Ltd. (Past President of SIMA), Mr. R. E. Burnett, M.A., M.I.C.E., of Marconi Instruments Ltd. (Vice-President of SIMA), Mr. G. S. Sturrock, M.A., F.C.I.P.A., of Kelvin & Hughes Division of S. Smith & Sons (England) Ltd., Mr. R. Y. Parry, of Isotope Developments Ltd., Major W. Logan, of Avo Ltd., Dr. F. Hamill, of Hilger & Watts Ltd., and Captain R. A. Villiers, C.B.E., A.M.I.E.E., Director of SIMA.

The objects of the SIMA delegation are:

To explain the scope and size of the industry and to make known the present methods for provision of information to users of instruments.

To receive information on the possible requirements of instruments for the Italian research programmes, and on the main fields of development in the engineering and manufacturing industry.

To discuss in principle how best the needs of Italian industry can be met and possible procedures for increasing co-operation.

To recommend to British manufacturers improved channels for providing information to Italian users of instruments.

The delegation is receiving the full support of the British Embassy in Rome and the British Chamber of Trade in Italy and the programme covers meetings with representatives of industry, Government authority and the Agip Nucleare (nuclear energy activities) and other official bodies in Rome, Milan, Naples, Turin and Florence.

Visit of Rumanian Delegation

After some delay and uncertainty Ing. Emilion Georgescu, Director of the Stat Pentra Metrologie of Rumania, arrived at very short notice and a very successful programme of visits was put into operation. Mr. Georgescu visited twelve member firms and before returning expressed his thanks to SIMA for all the assistance that had been given to him. He then stated how much he had enjoyed his visit and how useful it has been to his organisation to be able to meet British manufacturers first hand and to make so many valuable contacts.

Ultrasonic Executive Committee

The third meeting of the Executive Committee has now been held and initial reports have been submitted by two of the working parties. A considerable amount of preliminary work is now in hand and in addition a liaison has been achieved with the Ultrasonic Manufacturers' Association of America.

The working parties have now initiated a series of test programmes and it is hoped to produce an interim series of reports in December of this year. Representatives from the National Physical Laboratory, The British Scientific Instrument Research Association and The Medical Research Council are co-operating with SIMA as active or advisory members.

Exhibitions

Two further exhibitions have now been included in the list of SIMA promotional activities and a group stand has been organised for the Productivity Exhibition in April, 1962, and it is also hoped to have a group stand at the Finnish Trade Fair in September, 1962, under the auspices of the Board of Trade.

New Members

The following new members have been admitted to the Association:

Friston Electronics Ltd.
Measuring Instruments (Pullin) Ltd.
George A. Blake (Brentwood) Ltd.—Associate Member.

Apprenticeship Certificates

Apprenticeship certificates from the following member firms were submitted to Council and were endorsed:

C.B. Instruments Ltd.
R. & J. Beck Ltd.
Edwards High Vacuum Ltd.
Taylor, Taylor & Hobson.

The Protection of Circuits by Miniature Circuit Breakers

THE ELECTRICAL RESEARCH ASSOCIATION'S Report Ref. F/T197 deals with the protection of miniature circuit breakers.

These devices have an inverse current/time characteristic, that is to say, the tripping time becomes smaller as the current is increased. The minimum tripping current is usually set at about 25% over-current. There is, however, a minimum which seemed to be not less than about 10 m sec corresponding to one half cycle for a given miniature circuit breaker, which is substantially independent of the current. For a given temperature rise the time that a current may be permitted to flow in a cable under conditions of large over-current should be inversely proportional to the square of the current. When the minimum tripping time is reached the heating of the cable will then become proportional to the square of the current. This could, in some cases, impose a limit to the fault current that may be associated with a given combination of miniature circuit breaker and cable, which might be smaller than the maximum fault current that could otherwise be coped with.'

This report is concerned primarily with thermal effects in the protected cable during the operation of the miniature circuit breaker in a 250 V (nominal) circuit with currents up to 1,500 A at 0·8 pF and in these tests no instance occurred in which a cable was fused when protected by a miniature circuit breaker of the same rating. These values of current and power factor were chosen because they had been tentatively agreed in a C.E.E. Committee and there was no British Standard or draft Standard then available to serve as a guide.

Seven makes of miniature circuit breaker were tested, all of British manufacture. Rated currents were 2·5, 5, 10, 15, 20 and 30 A.

The full report, "The Protection of Circuits by Miniature Circuit Breakers", by H. W. Baxter, B.Sc., M.I.E.E., is obtainable from the Electrical Research Association, Cleeve Road, Leatherhead, Surrey, price 10s. 6d., postage 6d.

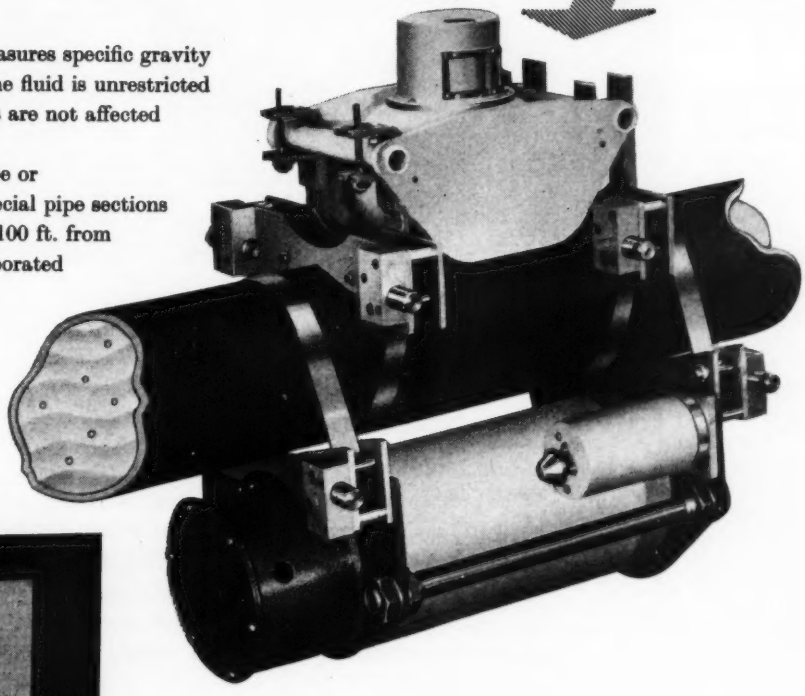
Circle 351 for further information

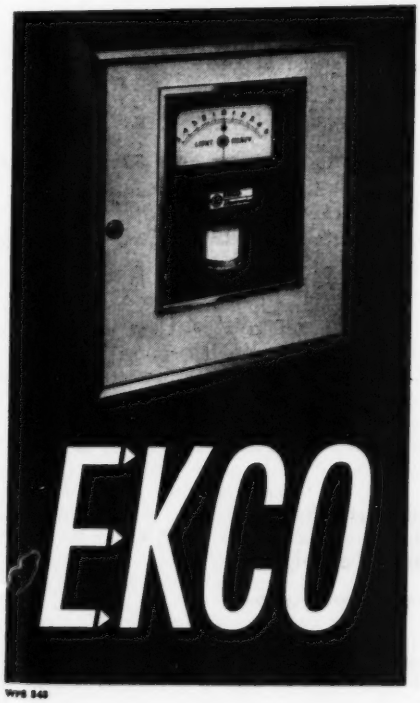
EKCO

Fluid Monitoring & Control

Fluid Density Gauge N611

* No direct contact with fluid * Measures specific gravity changes as low as 0.002 * Flow of the fluid is unrestricted * There is no 'head' loss * Readings are not affected by flow profile, viscosity or velocity * Economically fitted to existing pipe or tank installations and requires no special pipe sections or unions * Indicator may be up to 100 ft. from measuring head * Provision is incorporated for adding control or alarm facilities as well as remote metering and recording.





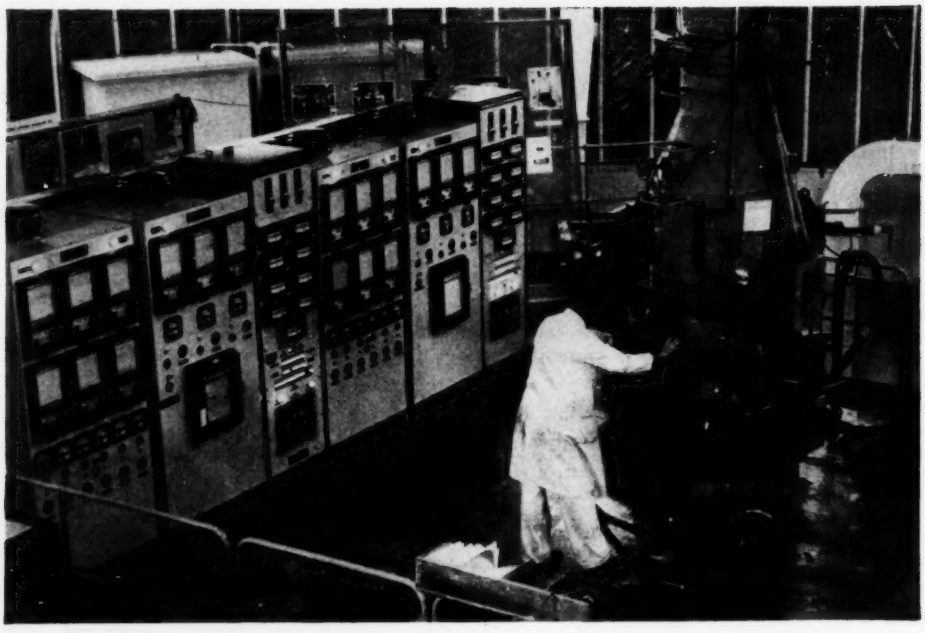
If you are concerned with—

Difficult chemical abrasive slurries, aggressive fluids, pastes, or inflammable liquids, then the Ekco N611 can probably solve an awkward measurement or control problem for you.

Consult the Ekco Electronics Technical Advisory Service without delay.

ELECTRONICS LTD SOUTHEND-ON-SEA · ESSEX SOUTHEND 49491

Circle **352** for further information



Complex problem at A.E.R.E. Harwell solved by Speedomax

The problem arose at Harwell of how to control within limits of ±1°C the temperature of Specimens being irradiated within the Pluto reactor and to ascertain the **effect** of known temperatures on these Specimens. Additionally, metallurgists required to know the result under identical conditions of control in an "out of pile" experiment which would simulate exactly all changes occurring in the reactor.

The equipment comprises 18 heater channels controlled by Speedomax "H" recorders with integrally mounted 3 term controllers working into 3 K.W. Saturable core reactors, with associated monitoring and safety circuitry.

Complicated? Yes, very, but Leeds Northrup are accustomed to solving complex problems.

Send us your enquiries for console or panel work.

LEEDS AND NORTHRUP LTD.
183 Broad Street Birmingham 15
Telephone: Midland 3031/6 *Telegrams: Flometer, Birmingham*

SURVEY OF NEW INSTRUMENTS

ELECTRICAL · ELECTRONIC · MECHANICAL · NUCLEONIC · PNEUMATIC

Valve Positioner

THE Fisher Type 3560V/P valve positioner has a frequency response greatly superior to that of the Type 3500 which it replaces; for example, its break frequency at 5% of full instrument pressure range has been improved from 0·15 to 3·9 c/s.

This improved frequency response overcomes the disadvantage of using a diaphragm actuator in a process control loop. Where a typical time lag may have been 1 second or more, the Type 3560 has reduced this to 0·03 seconds.

A new feature is the use of interchangeable characterised cams to enable the control valve characteristic to be more closely matched to the process characteristic. Where a characterised cam is installed in place of the standard linear cam, the relationship between instrument pressure and valve plug travel is changed so that greater instrument pressure changes are required to create a given change of flow through the valve. This helps to solve instability problems caused by an oversized control valve.

The Fisher 3560V/P can be converted from direct to reverse action or changed to split range operation by means of a few simple adjustments and without any additional parts. It can be mounted on any type of Fisher actuator yoke by means of mounting pads. Special mountings can also be provided for any other make of diaphragm actuator.

Circle **1** *for further details.*

Variable Phase Standard

A VARIABLE phase standard which allows the phase between two self-generated voltages to be shifted to any desired angle with a minimum accuracy of $\pm 0{\cdot}05°$ is now available from The Wayne Kerr Laboratories Ltd.

Operating over three adjustable frequency ranges between 150 and 3,000 c/s, this new instrument (designated VPS-1) generates two voltages of equal amplitude differing in phase by any angle from 0°—360°. The reference voltage has a fixed amplitude of 50 volts r.m.s. whilst the vector output, which may be displaced in phase in increments of one minute of arc, has a maximum amplitude of 50 volts r.m.s. and can be attenuated in 50 millivolt steps.

The instrument is self-contained, requiring no external equipment for calibration or operation, and is available in a case or ready for rack mounting.

Circle **2** *for further details.*

Magnetic Plastic

FERROMAGNETIC plastic materials, marketed under the trade name FERROTRON, are now available from Polypenco Ltd.

FERROTRON is a non-memory, inductive core material and has already been successfully used as antenna couplers in conjunction with high power transmitters in aircraft at intermittent service temperatures up to 350°C.

The new material has a positive Q coefficient and constant magnetic permeability. High dielectric strength and low dielectric losses are coupled with a volume resistivity higher than 10^{10} ohm-cm.

The new material is available in flexible rod and tape form and in short segments that can be readily machined for prototype evaluation. Production quantities can be supplied as moulded parts.

Circle **3** *for further details.*

Double-gun Helical p.d.a. Cathode Ray Tube

THE M-O Valve Co. Ltd. has added a new double-gun helical p.d.a. cathode ray tube to their range. It is a 10 cm diameter tube, Type 1000F, for use in general purpose oscilloscopes in which two independent signals are displayed on a common timebase.

Deflection sensitivity in the X direction is 24 V/cm and in the Y direction 14 V/cm with a gun voltage of 1·2 kV and a final anode potential of 4 kV. The line width is approximately 0·4 mm.

The two guns scan a common window of 6·3 cm × 6·3 cm. Side pin connections to the deflector plates contribute to low input capacitance. The overall length, excluding base pins, is 34·8 cm ±0·5 cm.

Circle **4** *for further details.*

Silver Star Capacitors

Two further capacitors in the Silver Star range are now available from Johnson, Matthey; Types C22E and C33E, both of which conform to Class H1 of the British Services' Climatic Specification, for working temperatures in the range −55 to +125°C.

The new components are of rectangular section and have tinned phosphor-bronze leads emerging perpendicularly from the base. The leads are suitably spaced for 0·1 or 0·2 in. module printed circuit boards, and are sufficiently rigid to support the capacitors, but if vibration or acceleration forces in service are high, the capacitor can be cemented in place.

Type C22E has a base of 0·710 × 0·210 in., and is 0·450 in. high. The corresponding dimensions for Type C33E are 1·130 × 0·315 × 0·625 in. Both are available for peak working voltages of 200 and 350 V d.c. and the total capacitance range covered by the two types is 5–33,000 μμF, with a minimum tolerance of ±0·5%, or ±1 μμF below 200 μμF.

Circle **5** *for further details.*

Plug-in Relay

DEWHURST & PARTNER LTD. have introduced the Type EB 2-pole changeover plug-in relay.

The EB relay has a wide range of applications including control systems where continuous and frequent operation (up to 3,600 per hour) is required.

Normally supplied for coil voltages of 24 or 220 V a.c., the relay is also available for voltages in the range 6 V to 110 V operating a.c. or d.c., or, with series resistor, 400 V a.c. or 220 V d.c.

The EB relay has an international octal base fitting, but a special plug-in baseplate is available for solderless wiring. Measuring $2\frac{3}{4} \times 1\frac{7}{8} \times 1\frac{3}{8}$ in. overall and weighing less than $3\frac{1}{4}$ oz, the relay will operate satisfactorily in any mounting position. Encased in clear plastic, it is completely dustproof.

The solid silver contacts need no maintenance and have a life of over 10 million operations, with a normal switching current capacity of 6 amp at 250 V a.c. or 2 amp at 400 V a.c.

For a.c. use the operating time is approximately 10 milliseconds and the release time 8 milliseconds, and for d.c. use operating and release time are approximately 8 milliseconds.

Circle **6** *for further details.*

Transistorised Cable and Pipe Locator

METAL DETECTION LTD. have available a fully transistorised cable and pipe locator, comprising an oscillator unit, a receiver unit and a search coil and earphones.

For locating underground pipes the oscillator unit is attached to one end and, in conjunction with the indicating meter in the receiver unit and earphones, the pipe position can be easily plotted by the operator.

The technique is similar for electrically isolated cables but in this instance the extreme end of the cable must be earthed.

For locating energised cables the oscillator unit is not required since the receiver unit will detect from the 50 cycle radiated power in the cable.

The unit is complete with built-in batteries, and is light and portable for field use.

Circle **7** *for further details.*

"Simcar" Level Controller

THE "Simcar" radiation switch is a robust and reliable industrial level controller suitable for use on all types of tanks, hoppers and bunkers. No parts are placed inside the container which may be of any material such as steel, concrete, wood, brick, etc. The "Simcar" radiation switch and a small radioactive isotope in its special holder are fitted at the required control position on the walls of the container, so that radiation passes from the source, through the container to the "Simcar" switch. When the level of material inside the container is above the control level the amount of radiation reaching the switch is reduced and its control relay reacts to perform any required switching function.

The switch consists of a gamma detector, the transistorised circuit of which is encapsulated and supplied housed in a robust dust-tight case or in a certified flameproof case. Because of its very high sensitivity only very small radio-active sources are normally required. The special source holders used have facilities for switching off the radiation when necessary.

The "Simcar" radiation switch was designed by the Research Department of Simon Carves Ltd., it is manufactured and marketed by A. M. Lock & Co. Ltd. and forms one of their range of industrial nucleonic type level control systems. Delivery is available from stock, delivery of the radio-active isotope is usually 2/3 weeks.

Circle **8** *for further details.*

Remanent Relay

MAGNETIC DEVICES LTD. have been appointed sole concessionaires for the manufacture and sale of the remanent relay developed by the Telephone Manufacturing Co.

The Series 355 remanent relay remains operated after removal of the energising current and will remain operational indefinitely until the application of a de-energising pulse.

Based on the Post Office 3,000 relay, the Series 355 differs only in respect of the core and armature. The core has a high retentivity.

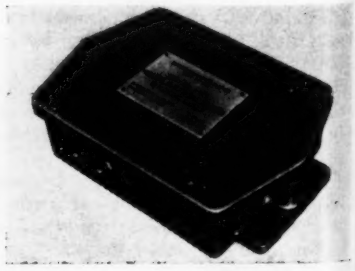
A contact, wired in series with the release winding, ensures that the release current does not produce excessive flux in the reverse direction, thus tending to re-operate the relay. This is fitted to the relay as standard.

Circle **9** *for further details.*

Type EB 2-pole changeover plug-in relay

Transistorised cable and pipe locator

Standard "Simcar" case



Rotation Monitors

THESE units have been designed to give a warning when a monitored shaft (or any reciprocating or linear motion) slows down or stops. Pulses obtained from the shaft by means of any of the various types of Pentechnique magnetic transducers hold a relay in the shaft rotation monitor in an energised condition. When the shaft stops rotating the relay becomes de-energised and the relay contacts actuate alarm signals, warning lights or other control signals. Semiconductor devices are used throughout and a power supply is incorporated enabling the equipment to be operated from normal mains supplies. No warm-up time is necessary.

The possible applications for this equipment include the control of safety guards on manually-fed presses, the monitoring of unattended machinery, the control of gas burners on glass welding machines and strip rolling mills, the actuation of hour meters on vehicles when the vehicle is in motion, flow monitoring, break detection on paper, wire and thread reeling machines and any process where a mechanism may stop even though power is applied.

Although normally intended for use with magnetic pick-ups, versions are available for use with switch contacts and photo-electric pick-ups.

Measuring 6 × 4¼ × 3½ in., these monitors can be supplied with either wall (surface) mounting or panel (flush) mounting cases.

Both versions are fitted with mains switches and warning lights and the internal relay is of the dust-proof plug-in type with 2-pole changeover contacts rated at 250 volts 5 amp a.c.

Special versions can be supplied to switch at specified shaft speeds and other modifications include the provision of alternative relays, power transistor output stages (for the direct operation of small solenoids), variable delayed pull-in and drop-out circuits, and power supplies for different mains voltages. Prices range from £17 13s. 0d. upwards.

Circle **10** *for further details.*

Mixed Gas Thyratrons

THIS range of valves from Associated Electrical Industries Ltd. (Electronic Apparatus Division) is designed to combine the advantages of mercury-vapour and gas-filled thyratrons and to overcome the limitations inherent in both types. They are filled with inert gas as well as mercury, thus achieving short cathode heating time, operation within a wide range of ambient temperature, and long reliable service life.

The two types, BT 111 and BT 113, are rated for a maximum peak anode voltage of 1,500 volts and maximum cathode currents of 30 and 2 amp peak, 2·5 and 0·5 amp mean, respectively. The ambient temperature range is −40 to +40°C but, for maximum life, it is recommended that the valves be operated in the range of +15 to +40°C. Cathode heating time is 30 seconds for the BT 111 and 10 seconds for the BT 113.

These thyratrons are intended for industrial applications and the BT 113 can be used as a plug-in replacement for the BT 19 mercury-vapour thyratron. They are fitted with standard valve bases.

Circle **11** *for further details.*

Ultra-violet Detector Heads

ELCONTROL have developed two ultra-violet detection heads which will allow the ultra-violet detection of flames to be utilised where necessary.

These u.v. detection heads involving, as they do, extra stages of amplification are necessarily more expensive than the infra-red flame electrode and visible light heads.

These heads utilise easily available replacement photocells and may be connected to any of the Elcontrol Standard FSM1, FSM5, 6 series units which include programming and other facilities and also may be utilised with the modular series of flame relays (FR5 & 6) and control units (CU1).

They are alternative to the VH31P, VH101P, VH102, FE3, FE2B types of visible light, infra-red and conductivity detectors.

Both heads consist of a special u.v. photo-sensitive cell having a relatively high temperature stability housed in a cast aluminium head with an asbestos gasketed cover.

Type UV1 head is connected via a standard 6 ft armoured 4 core cable to the control unit terminating in a 4 pin cinch plug.

Type UV2 head is connected with two cables, both 6 ft long and in armoured flexible conduit, one, the detection cable, terminating in a 4 pin cinch plug and one, the power cable, running back and looped in to the standard 240 V mains supply in the FSM control box.

The UV1 head is for use on flames which have a large amount of modulated ultra-violet and for occasional use in all single burner installations while the UV2 is for use where greater discrimination is required as on multi-burner installations and on very steady flames having little natural flicker of emitted ultra-violet light.

It should be remembered that all radiant bodies emit a certain amount of ultra-violet, but the amount emitted by flames is correspondingly greater.

The ultra-violet photocell used is inherently responsive up to 90°C and does not fail catastrophically even at that temperature. The rest of the components will ultimately be capable of working up to this temperature though in present designs an insulating heat block tube is desirable and temperature should be kept below 65°C.

No thin or fragile glass windows are employed in this device.

Price.

Type UV1 — £25.
Type UV2 — £35.

Circle **12** *for further details.*

Hermetically Sealed Instrument

A NEW range of hermetically sealed platform scale instruments weighing 2¼ oz, with a scale length of 1¼ in. and a viewing distance of 18 in., has just been brought out by Measuring Instruments (Pullin) Ltd.

The Series 125, as they are known, have received a full type approval certificate from S.R.D.E. to their specification 230/2 (Certificate No. 195-2).

The 125 is also physically and electrically equivalent to the 1½ in. hermetically sealed instrument in Specification DEF.62 when used with terminals instead of soldering posts.

The immediate and obvious application for these new instruments is for aircraft and in a wide range of service testing equipment, as well as in personal radiation dosemeters. But there is also a wide field of application in industry itself, especially where conditions of high humidity are experienced or in processes involving atmospheric pollution, or vibration.

The case, which is black anodised aluminium in order to keep weight to a minimum, has an outside diameter of approximately 1·77 in. It provides a sealed compartment for dry nitrogen at normal pressure.

The scale presentation has graduations and figuring generally in line with the new draft British Standard AB(INE) 1661.

A platform scale has been added to overcome parallax error and to increase the clearance between the pointer and the dial so that under severe vibration the pointer does not touch the sub-dial.

The scale is very easily read since the pointer is approximately three times the normal length.

The Series 125 is "non-fogging" even after rapid reduction in temperature. The limiting temperature range for normal moving coil instruments is −40 to +85°C. For rectifier voltmeters the range is −40 to +55°C. Furthermore, the internal magnet movement on which the Series 125 is based is self-screening and remains unaffected by normal external fields.

As regards ranges, the Series 125 is supplied for d.c. volts (50 millivolts—250 volts), a.c. volts (2·5 volts up to 250 volts) and as an ammeter for d.c. current (50 microamp up to 5 amp). The preferred scale ranges are 0-10, 15, 20, 30, 40, 60, 80 and decimal multiples.

Circle **13** *for further details.*

Compressed Air Filters

C. A. NORGREN LTD.'s range of compressed air filters, Series E30BE, are available in pipe sizes of $\frac{1}{4}$ in., $\frac{3}{8}$ in. and $\frac{1}{2}$ in. and replace their previous Series E30AE manual drain filters.

Features of this new range of units include:

1. 100% liquid removal over a full range of air flow capacity. Improved baffling makes possible the complete removal of this liquid.
2. Large bowl capacity for collected liquid.
3. Quick two-step complete disassembly for cleaning.
4. New rugged transparent bowl with higher safety factor and greater resistance to fatigue under cycling loads.

A 64-micron sintered bronze element is the standard filtering medium for solids although alternative elements available include 25-, 10- and 5-micron sintered elements and additionally a 74-micron 200 mesh reinforced monel screen element.

Units are available with metal bowls for higher temperatures, pressures and rougher usage.

Maximum temperature and pressure limitations are as follows:

Transparent bowl 150 lb/in² and 120°F
Metal bowl 250 lb/in² and 300°F.

All units are list price £4 10s. 0d.

Circle **14** *for further details.*

The "Porotest" 20

The "Porotest"—for Locating Faults in Coated Surfaces

THE POROTEST 20 is designed to locate and give an immediate indication of faults in protective coatings up to 10 mm thick.

The equipment consists of a portable high voltage producing unit with a probing electrode connected to the unit by a flexible lead. The electrode has an insulated handle, incorporating a neon indicator lamp, and a head made of a flexible conductive material. A trailing earth lead is also supplied.

An external selector switch is fitted so that the voltage output may be varied between 3,000 and 20,000 volts in order to cater for a range of coating thicknesses up to 10 mm.

After connection to the main supply and selecting the output voltage to suit the thickness of coating to be tested, the earth connection is made and the instrument switched on.

The electrode head is brushed over the test surface. Where a fault occurs, current flows to earth and illuminates the neon indicator lamp fitted to the handle.

The POROTEST 20 is suitable for testing and locating faults in paint films, coal tar and bitumen coatings, enamel and glass coatings and linings, plastic coatings, etc.

Delivery is 4/5 weeks and the price is £212.

Sole British agents are: The Acru Electric Tool Mfg. Co. Ltd.

Circle **15** *for further details.*

Small-scale Computer—KDN2

THE English Electric Co. have developed a small-scale general purpose electronic digital computer, the KDN2. KDN2's applications cover the direct control of industrial processes, data processing and scientific computing, the scanning and recording of temperatures, pressures, etc., and "slave" work for large scale computing systems such as English Electric's KDF9 and KDP10. It is manufactured at the Company's Data Processing and Control Systems Division at Kidsgrove, Stoke-on-Trent.

The KDN2 consists basically of three units:

(a) a cubicle containing the high speed store, logical circuitry and the various power supply units and protective interlocks

(b) a control desk on which the paper tape reader and punch units are mounted and the control panel for switches, indicating lights, etc., for programming and operational control of the computer and

(c) a small cabinet supporting the electric typewriter and housing its associated power supplies and control circuitry.

The logical circuitry of KDN2 is provided by the English Electric Datapac units designed on the building block principle, which can cover over 70 different logical functions to build up any system of electronic data handling or control. The main store of the computer is provided by a transistor-driven ferrite core matrix and is expansible in increments of 512 18-bit words up to a maximum of 4,096 words. Auxiliary storage in the form of magnetic tape units can also be provided.

KDN2 will work through a normal programme at a rate of approximately 6,000 instructions per second, the actual speed of operation depending on the functions being obeyed.

KDN2 has a straightforward single address instruction code and alpha code is also available for use with the machine.

As its standard input and output, KDN2 is fitted with paper tape reader and punch, both operable at 20 characters per second, and is capable of handling 5, 6, 7 or 8 hole paper tape in widths from 11/16 in. to 1 in. An electric typewriter operating at the rate of 10 characters per second is a standard feature of the basic machine. A wide range of peripheral equipment can be used with the computer to meet all applications. This includes faster paper tape equipment, card readers and punches and binary and decimal keyboards. Switches, keys and counters may be used as input devices, and line printers, audible and visual alarms and lamp displays can be incorporated in the system as required.

For process control applications, appropriate input and output equipment can be provided together with analogue-to-digital and digital-to-analogue conversion units. Without modification to the central computer, special purpose peripheral devices such as random number generators or photo-electric measuring devices can be incorporated as required. When suitable buffering facilities are provided, KDN2 can be used to control standard high performance magnetic tape units, such as those used with the English Electric KDP10 and KDF9, and this enables the computer to be used as a satellite for a large scale system.

Circle **16** *for further details.*

Digital Voltmeter-Counter

A COMBINED digital voltmeter—frequency meter—time interval meter—clock pulse source has been designed and is being manufactured by Southern Instruments Ltd.

The instrument measures from 1 mV to 500 volts. It measures from 0·1 c/s to 120 kc/s using a count period of 0·1, 1 or 10 sec. It measures intervals, defined by electrical signals or contact closures, of 1 ms to 27·7 h. Also it provides crystal controlled clock pulses of 0·1, 1 and 10 ms, 0·1, 1 and 10 sec. On all functions the input impedance is of a high order.

It has a combined function and range selector switch.

A bright display with a wide viewing angle is achieved with projection type in-line indicators. A latching system, which is released momentarily at the end of each count, provides a continuous display that is uninterrupted by the counting period.

The instrument is mains powered, and is compact, portable and robust, making it equally suitable for laboratory and industrial applications. Quantity production will be undertaken at the end of 1961.

Circle **17** *for further details.*

Dielectric Polystyrene

A DIELECTRIC material for the electronic and electromechanical industries, known as Polypenco Q-200.5, has negligible water absorption, is transparent and may be used permanently at temperatures of 100°C. For short periods of time the material is form stable up to temperatures as high as 204°C.

The loss tangent of the material compares favourably with that of p.t.f.e. and polythene and both volume and surface resistivities are better than p.t.f.e. at low frequencies. The dielectric constant is subject to little variation over the widest frequency range.

Polypenco Q-200.5 cross-linked polystyrene can be supplied from stock in round rod form $\frac{3}{32}$ in. to 3 in. diameter and in plate form $\frac{1}{8}$ in. to 1 in. thick.

Circle **18** *for further details.*

1·5 W Zener Diodes

THE SZA/C series of silicon Zener diodes, from G.E.C., formerly of ±10% tolerance now has a nominal tolerance of ±5% and stretches from 5·6 V to 33 V. Maximum mean power dissipation at 40°C is 1·5 W and the diodes are enclosed in a double-ended case with wire leads and a threaded base.

The diodes are numbered SZ56A to SZ91A and SZ10C to SZ33C with nominal Zener voltages of 5·6 V to 33 V, graded according to the international preferred values of the 10% increment series. Typical temperature coefficient of breakdown voltage varies between +0·02%/°C for SZ56A to +0·09%/°C for SZ33C.

Circle **19** *for further details.*

High Current Power Supplies

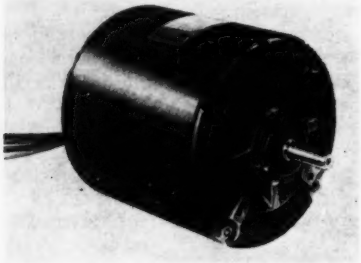
KASAMA ELECTRONIC'S latest range of transistor stabilised power supplies are designed to give high current outputs up to 50 amp, and 5 units are available. These are Type KTV/310, KTV/320, KTV/330, KTV/340 and KTV/350, giving 10, 20, 30, 40 and 50 amp output respectively. These supplies give a voltage range of 0 to 30 V which is continuously variable. The source resistance is 0·003 ohms. Ripple is 1 mV peak to peak, and the voltage and current are monitored on separate meters. All units are provided with overload cut-outs which can be set to any desired tripping current. The outputs are fully floating, the stability factor is 1,000: 1.

Circle **20** *for further details.*

FHP Motors

CROMPTON PARKINSON LTD. are introducing a new range of fhp motors which comply with the requirements of B.S.170 and have the mounting dimensions of American standard "NEMA" 42.

There are four main types of motor, (a) shaded pole, which is a new addition to the Crompton Parkinson range and has been specially designed to ensure a low noise level, (b) capacitor start induction run, (c) capacitor start and run, and (d) split-phase start. These four types are all available with drip-proof enclosure, and, in addition, the shaded pole motor can be supplied as totally-enclosed airstream and totally-enclosed still air rated.



T.30 fractional horse power motor

The motors with resilient base have a centre height of $2\frac{5}{8}$ in.

Designated T.30, this new range of motors makes provision for four methods of all-angle mounting, including resilient base, resilient rings without base, endshield pad with tapped holes and endshield pad with extended studs.

In order to comply with "NEMA" standards, the new motors have a $\frac{3}{8}$ in. diameter shaft extension. Bearings, however, allow for $\frac{1}{2}$ in. diameter shafts to be provided at either end of the machine for small extra cost.

The oil wells, when charged, contain enough oil for two years' running at normal ambient temperatures and hours of operation.

The split-phase and capacitor start induction run motors employ a starting relay which is separately mounted and is suitable for all-angle mounting. Capacitors for capacitor start induction run and capacitor start and run motors are also separately mounted.

Loose lead connections are brought out through the shell at the non-driving end.

Large rotor cooling fins dissipate heat and act as fans to cool the stator windings. Polyvinyl acetyl resin is used to insulate stator windings: this makes the windings stronger electrically and mechanically.

The T.30 range is available for single-phase working from 1/40 hp at 1,350 rev/min, as a shaded pole totally-enclosed still-air motor, up to $\frac{1}{4}$ hp at 1,425 rev/min as a drip-proof split phase or capacitor motor.

Circle **21** *for further details.*

Numerical Indicator Tube

MULLARD have available a cold cathode numerical indicator tube with improved operating life. Its life expectancy is 30,000 hours provided the display is changed from one numeral to another more than once in 100 hours, or 5,000 hours with continuous display of any single numeral.

An additional feature of the Z520M is a built-in optical filter which ensures maximum readability of its numerals under all conditions likely to be met in pratice—even direct sunlight.

The numerals are displayed in characters $\frac{5}{8}$ in. (15·5 mm) high. The tube can be operated with a supply voltage of 170 V. A cathode current of 2 mA is recommended.

The tube may be operated by applying either a steady d.c. voltage or a negative pulse to the appropriate cathode.

The Z520M is similar both in structure and electrical characteristics to the earlier Z510M. Physical dimensions are: 28·5 mm (±1·5 mm) diameter by 25 mm (±1·5 mm) seated height. The tube has a B13B base.

Circle **22** *for further details.*

Vacuo-junction Tubes

BEST ELECTRICS LTD. vacuo-junction tubes are specialised thermal converters which may be used as a.c.—d.c. transfer standards over a wide range of frequencies.

The operation of these devices depends on the fundamental fact that, when two dissimilar metals are placed in contact, a small d.c. voltage is developed. Over a limited temperature range the magnitude of this thermal e.m.f. is proportional to the junction temperature.

In the vacuo-junction tube, the junction is placed in thermal contact with a heating filament, which carries the current to be measured. The structure is contained in an evacuated glass envelope to minimise heat losses. Since the thermal e.m.f. developed is proportional to the junction temperature, it will now also be proportional, in turn, to the square of the heater current.

By measuring the thermal e.m.f. on a suitable calibrated millivoltmeter, an indication is given of the applied current. If the instrument is calibrated on d.c., then the same calibrations will hold, within very close limits, on a.c. Further, since the vacuo-junction measures the heating effect of the applied current, indicated readings will be true r.m.s. values, regardless of waveform. Within the frequency range 25 c/s—20 kc/s, the Best standard pattern vacuo-junction is accurate to within 0·01% for all measurements.

Three patterns of Best vacuo-junctions permit, between them, accurate measurement over a frequency range extending from below 0·1 c/s to several hundred megacycles. Each pattern is available with a variety of heater ratings, the most sensitive being rated at 1 mA maximum heater current.

By arranging for one vacuo-junction to measure the current flowing in a circuit, and for another to measure the derived voltage of the same circuit, then the resultant thermal e.m.f. of the two junctions, when combined, will indicate the power consumed in the circuit.

In addition to the standard ranges, Best Electrics Ltd. can supply vacuo-junctions with characteristics arranged to meet users' own particular requirements.

Applications include: measurement of a.c. currents, voltages and power; measurement of serial current in radio transmitters; measurement of effective current

in loudspeakers; calibration of valve voltmeters; indicators for stray h.f. currents. In addition, Best vacuo-junctions have been successfully used in an unsealed form as the sensing element in vacuum measuring equipment.

Circle **23** *for further details.*

Compressor protective equipment. Left to right: indicator unit, alarm bell, oil level switch, water flow indicator, flameproof control and indicator unit

Compressor Protective Equipment

TEDDINGTON INDUSTRIAL EQUIPMENT LTD. have produced a new line in compressor protective equipment. It is known as the "Series 200" and was originally developed in collaboration with the National Coal Board to provide automatic protection of air compressor plant, both in surface and underground applications. It is capable of providing, without modification, automatic protection against a combination of different hazards and it is designed to be serviced, by replacement, both simply and quickly.

The "Series 200" gives both visual and audible warning when a fault condition develops, and it automatically operates to shut down the compressor in order to safeguard both plant and personnel. After the fault has been rectified it is only possible to reset the equipment by the use of a special key, which can be left in the care of an authorised person. In the event of a fault occurring within the equipment itself, the protective devices fail safe and the compressor is automatically shut down.

The equipment consists of the Teddington indicator unit, an intrinsically-safe box (Group 1, Methane, B.S.S. 299:1957), a control and interlock unit and an alarm bell. Ancillary protective devices, viz. an oil level switch and a water flow indicator, are also available. The visual indicators and their associated circuitry are housed in the indicator unit and the protective devices are mounted externally on its underside.

The plugs on the indicator unit, with which the protective devices mate, are interchangeable, in as much as every plug can accommodate any one of the four types of protective device. Indicator units equipped to take 4, 6, 8, 12 or even 20 devices are being produced. It is not essential to utilise every plug position, for bridge plugs are provided to complete the circuit when a protective device is not required.

A control and interlock unit has been developed by John Davis & Sons (Derby) and it is currently used, in coal mining applications, together with the Teddington equipment. It contains the relays that operate to shut down the compressor and energise the alarm bell. In addition, it contains a delay circuit which overrides the pressure protective device while the compressor is running up to speed.

Variations of the current control and interlock system are available. An intrinsically-safe transformer to supply the indicator unit, together with a time delay to override the pressure protective devices, may be used by itself. Under these circumstances the temperature fault and pressure fault circuits may be connected directly into the compressor that is under protection.

The thermostats have an accuracy of $\pm$ 4°F and are unaffected by the depth of installation or the barometric pressure. The pressure switches are accurate to within $\pm$ 1·5 lb/in². On a recent life test carried out at the Teddington Works, a pressure switch completed no less than 3,257,336 successful operations without any signs of deterioration.

Circle **24** *for further details.*

Attachments for Recording Spectrophotometer

AMONGST developments from the Carl Zeiss works available through Degenhardt & Co. Ltd. are two new attachments for their recording spectrophotometer, Type RPQ 20 A.

The two new attachments are:

1. A flame attachment for the continuous recording of flame spectra tracings. This attachment provides a rapid method of qualitative and quantitative analysis. It has an atomising burner which is fed with oxygen and hydrogen, or acetylene. The sample is introduced via the oxygen stream and is sprayed directly into the turbulently burning flame.
2. A fluorescent attachment for recording tracings of fluorescent spectra. This attachment employs a mercury lamp and light filters which isolate lines of 313—365—405—436—546 and 578 μ.

   It also includes an arrangement for tilting the cell in order to facilitate measurement of heavily fluorescent substances. In this way the radiation can be received perpendicularly to the axis of the incident rays.

The recording velocity is variable in steps of 4·5—9—18 and 36 minutes, and the determinable spectrum range extends from 200—2,500 mμ.

Various types of cell are available according to the substance to be measured and the cell-holder is temperature controlled. Voltage stabilisation ensures that measurements are unaffected by mains voltage fluctuations of up to 10%.

Circle **25** *for further details.*

Receiver Units

RECEIVER units from Magnetic Broadcasting Co. Ltd. for interpretation at conferences dispense with the necessity of wired seats, and give the user complete freedom of movement.

The receiver units consist of a miniature transistorised amplifier with induction pick-up. They are light in weight, comfortable to wear suspended from the ears, do not occupy any pockets and leave the hands free. They operate by magnetic induction in the audio frequency range from a single loop of wire encircling the hall and an unlimited number of persons can be provided for.

Circle **26** *for further details.*

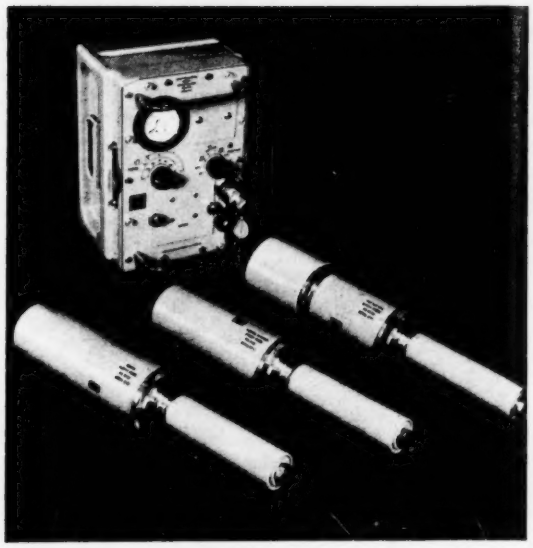
Selective Gamma Monitor

PLESSEY NUCLEONICS LTD. has introduced a compact selective gamma monitor, Type PNI 1118, capable of detecting small quantities of those radio-active materials emitting gamma rays in the energy range 10 keV to 1·5 MeV. The monitor detects these rays by means of a scintillation counter followed by a single channel pulse amplitude analyser. All circuits employ transistors. The monitor is mains or vehicle battery operated, is readily transportable, and is provided with six feet of connecting cable between the indicator unit and detector probe.

The detector probes available cover the ranges 10-60 keV, 50-300 keV and 250 keV–1·5 MeV respectively, and consist of thallium activated sodium iodide scintillators mounted on the end of photo-multiplier tubes. Adjustment of e.h.t. is provided on the individual probes, and the connection of any one probe automatically sets the required e.h.t. The supply is variable from 500-1,500 V.

Threshold bias is pre-set for the single channel pulse amplitude analyser, and channel width is switched to give 50%, 25% and 10% channels on the 10-60 keV, 50-300 keV and 0·25-1·5 MeV ranges respectively. Channel widths are pre-set internally.

Circle **27** *for further details.*



Portable neutron gamma monitor

"Speedivac" Coating Units

FOLLOWING a major research and development programme in the Coating Research Laboratory of Edwards High Vacuum Ltd. a new series of medium sized " Speedivac " coating units has been introduced replacing Models 18E4, 18SE4 and 19VE5. Designated the 19E series, this range at present comprises five basic models: the 19E2, 19E3, 19E4, 19E6 and 19E7. The basic unit is common to all models in the series and incorporates new design features including an hydraulic hoist for the new stainless steel chamber, a 400 A low tension supply and a shutter to permit immediate termination of evaporation.

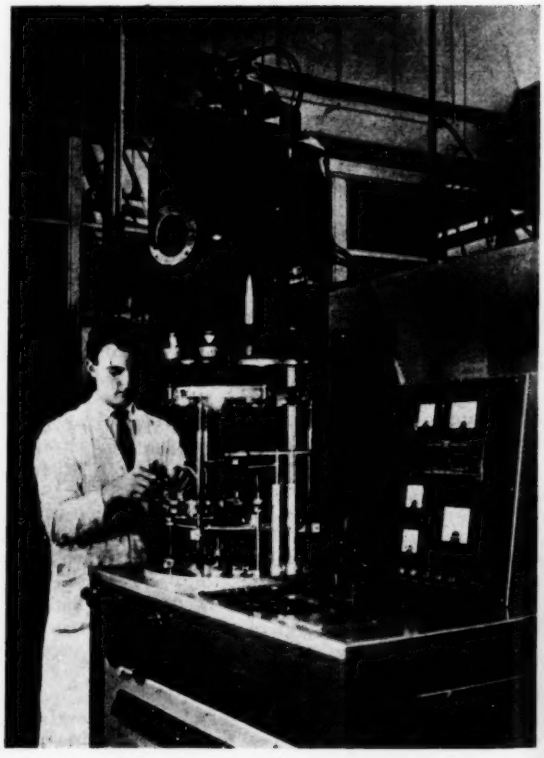
In the 19E series a chamber pressure better than 10^{-5} torr can be attained if desired and the " Speedivac " Penning type gauge fitted provides indication down to this pressure region. Where even lower pressures are required a coil type trap, with liquid nitrogen circulation, can be provided as an accessory, together with a suitable pump.

Each model has baseplate fittings making it particularly suitable for a specific group of duties:

Model 19E2 for the evaporation of single layer anti-reflection coatings or other single layer films on small components, it is also suitable for all general evaporative coating. This unit replaces the Model 18E4.

Model 19E3 for the deposition of single layer coatings on small components by sputtering or evaporation in separate cycles. Intended primarily for sputtering duties, this unit is provided with a 14 in. (356 mm) diameter water-cooled cathode, plated or unplated to order, with a high tension d.c. power supply. This unit replaces the Model 18SE4.

"Speedivac" coating units



Model 19E4 for the sequential evaporation of more than one material on to small flat surfaces by means of a heavy duty six position vapour source turret assembly, the work holders being provided by the operator.

Model 19E6 for the uniform evaporative coating of small or large plane surfaces. A motor driven plane rotary workholder is fitted above a six position vapour source turret assembly enabling single layer or multi-layer deposition to be carried out. This unit replaces the Model 19VE5.

Model 19E7 for the deposition of uniform single or multi-layer coatings on small or large plane surfaces by evaporation or sputtering. Similar to the Model 19E6, this unit also features patented water-cooled sector cathodes for sputtering. This unit replaces the Model 19VE5 with sector cathode accessory.

A " Speedivac " modulated beam photometer can be fitted to all the units in the 19E series for the measurement of film thickness during deposition, in terms of reflectance or transmittance. The photometer is supplied as a standard fitting on the Models 19E6 and 19E7 units, being available as an accessory for the Models 19E2, 19E3, and 19E4.

Circle **28** *for further details.*

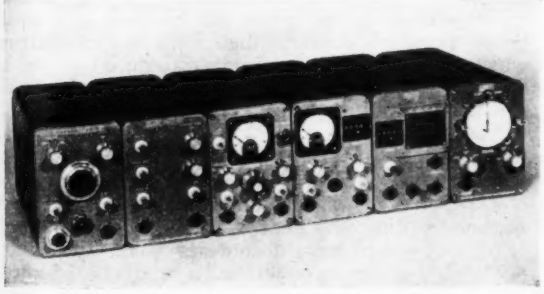
Transistorised Nucleonic Instruments

NUCLEAR ENTERPRISES (G.B.) LTD. are manufacturing a series of transistorised and printed circuit nucleonic instruments which have been developed by the company in conjunction with the U.K. Atomic Energy Authority. The series is composed of a number of functional units built in standard blocks of uniform dimensions (4 in. wide × 6 in. high × 10 in. deep) and the individual units may be combined in a variety of ways for different experimental investigations.

The NE 5252 amplifier has an overall voltage amplification of 1,000 times with a pre-amplifier stage for high input impedance, and three amplifier stages, each with ten times amplification. The unit features good linearity and low noise, and power is obtained from a companion unit (NE 5352).

The NE 5152 analyser is capable of accepting random pulses at a rate of approximately 30,000 pulses per second, and it has a channel width which can be varied continuously from 0·2 volts to 1·0 volt. The total range of the pulse amplitude level control is 10 volts and the amplitude level may be swept manually, or by a sweep recorder using an external bias control, or by an internal sweep circuit, permitting display on a memory oscilloscope.

Transistorised functional units showing, from left to right: power supply, amplifier, analyser, ratemeter, scaler and timer



The power unit (NE 5352) supplies both the l.t. for several units and the e.h.t. for photomultipliers, Geiger-Müller tubes or proportional counters. The e.h.t. is continuously variable from 500 volts to 3,000 volts. The maximum counting rate of the NE 5452 ratemeter is 30,000 pulses per second in 8 ranges, and below 10 counts per second pulses are counted on an electro-mechanical register.

The NE 5072 scaler has a resolving-time of 1 microsecond and can store 10^9 counts. The display is by neon bulbs up to 10^5, and the remaining four digits are shown on an electromechanical register. The sixth unit, the NE 5052 timer, produces pulses at half-second intervals by a stop-watch and elapsed times from 5 seconds to 20,000 seconds may be selected.

Circle **29** *for further details.*

Decade Capacitors

THREE new types have been added to the General Radio Co. line of decade capacitors.

Type 1423-A precision decade capacitor is a four-dial instrument with an in-line readout displaying selected values in large bold numbers for maximum readability. A flexible and versatile tool, it is an accurate standard for use in calibration laboratories and for production-line measurements. Four individual silver-mica capacitors provide 11,110 discrete values of capacitance in steps of 100 pF between 100 pF and 1·111 μF, each to an accuracy of ±0·05%.

Decade switches and associated capacitors are mounted in an insulated metal compartment, which in turn is mounted in a complete metal cabinet. This double-shielded construction makes the unit equally useful for either 2- or 3-terminal measurements. Independent adjustments make it possible to reset the terminal capacitance precisely to the nominal value at any time. Stability is better than ±0·01% per year.

Housed in an aluminium cabinet, 485 × 180 × 250 mm overall, the 1423-A is available for either bench or relay-rack mounting.

The second new decade is the Type 1424-A standard polystyrene decade capacitor which provides standard values of capacitance from zero to 10 μF. Twenty selected 0·5 μF heat-treated polystyrene capacitors are paired to provide ten 1 μF ±0·25% sections. They are housed in two hermetically-sealed brass cases with teflon-insulated high terminals, the case being common. The capacitor can be used in either a 2- or 3-terminal connection, with no significant difference in capacitance values. A calibration chart is provided giving the actual capacitance at each of the ten switch positions.

The Type 1424-A is mounted in an aluminium cabinet 205 × 195 × 240 mm overall.

The third addition to the line is a 4-dial polystyrene decade capacitor, Type 1419-B, with four individual polystyrene capacitors, that is accurate to ±1%.

Capacitance values are from zero to 1·110 μF in steps of 0·001 μF. Terminals are provided for both two- and three-terminal connections.

Designed to be essentially non-inductive, the units are heat-treated to improve long-term stability.

Low dielectric absorption, high-insulation resistance and increased capacitance stability make this capacitor suitable for development work on d.c. circuits, filters, tuned circuits, computers and integrators.

The 1419-B is enclosed in an aluminium cabinet that is 110 × 415 × 130 mm overall.

The capacitors are available in this country through Claude Lyons Ltd.

Circle **30** *for further details.*

Quick Release Couplings

FOLLOWING their appointment as sole sales concessionaires in the U.K. and Commonwealth, Aero Controls Ltd. have available a range of Wiggins quick release self-sealing couplings.

There are four basic types within the range—Connect-O-Matic, Inst-O-Matic, Min-O-Matic and Non-latching.

Connect-O-Matic

Push to connect, pull to disconnect, flush valve design, self-sealing, zero-leakage connectors which are suitable for high and low pressure fluid and pneumatic cooling systems.

Their design ensures minimum spillage while disconnecting and minimum air-inclusion while connecting. They disconnect under 3,000 lb/in² and connect up to 50 lb/in² minimum. Positive sealing is achieved by the use of dogs which lock on to a nipple and, when the coupling is disconnected, an actuating ring stays back for easy snap-into-place connection.

Inst-O-Matic

Quick connect, quick disconnect connector; lighter, smaller and less expensive than Connect O Matic which is suitable for hydraulic, fuel, oil and general fluid systems as well as for many electronic cooling applications. Connection is effected simply by holding back the retaining ring and snapping the connector into place. Disconnection is effected by pulling back on the retaining ring.

Inst-O-Matic features include—unique dog-locking design prevents brinneling of nipple; easily withstands vibrations of 20 *g* at 2,000 c/s; reduced turbulence because of valve guides; allows connection and disconnection under pressure; positive full flow; protected valves eliminate accidental spillage or damage; available in a complete range of line sizes; dog-latching mechanism permits flanged breakaway action for staging and panel applications.

Min-O-Matic

Miniature, lightweight, self-sealing, quick connect and disconnect, fluid connector which is for general and military applications, and particularly for electronic cooling applications. Sizes $\frac{1}{4}$ in. with $\frac{1}{4}$ in. ends also $\frac{1}{8}$ in., $\frac{5}{16}$ in. and $\frac{3}{8}$ in. ends on request. Made from aluminium with Viton " A " seals, also stainless steel and various elastomers on request. Pressures up to 5,000 lb/in². Temperatures from −20 to +400°F. Interchangeable components facilitate maintenance. Particularly suitable for klystron, magnetron, electron guidance units, testing, instrumentation and sensing lines.

Non-latching

Push-pull connectors with many of the features of the latching type, including flush valves, minimum spillage, minimum air-inclusion. Specially useful for cooling modules and pull-out units.

Circle **31** *for further details.*

Null Indicators

Two transistorised null indicators, the N1-2 and N1-3, for laboratory, production or field operation are now available from The Wayne Kerr Laboratories Ltd. Both models are phase-sensitive and may be combined with any standard Wayne Kerr-Gertsch ratio transformer to produce a precision a.c. ratio bridge.

Three ranges of sensitivity are provided: 10 μV, 100 μV and 1,000 μV, the high range allowing excellent resolution for bridge circuit operation. Either model can also be used as an amplifier over the frequency range 25-100,000 c/s with a selectable gain of 50, 500 or 5,000.

The phase-sensitive detector provides quadrature voltage rejection and a centre-zero meter indicates the degree and sense of unbalance.

Model N1-2 is supplied in a portable form and is battery operated, thereby eliminating stray capacitance and earth loop measuring problems; model N1-3 is a $3\frac{1}{2}$ in. high rack-mounted instrument containing an internal a.c. supply.

Both models have a minimum input impedance of one megohm and reference voltage amplitude ranges of 1-5 V, 5-25 V and 25-125 V.

Circle **32** *for further details.*

Ultrasonic Ball Point Writing Instrument

AN ultrasonic ball point writing instrument has been developed by Ultrasonic Industries Inc., Engineers Hill, Plainview, L.I., New York. The device, capable of writing at a linear speed of 9,000 ft/min, requires no writing fluids or marking compounds of any sort. It produces high contrast, high visibility markings on paper materials. The writing is permanent and as durable as the paper itself. The only means of eradicating the marking is by destruction of the paper. The marking is unaffected by sunlight, temperature, or water and will not fade or wash out as in the case of conventional writing instruments.

The ultrasonic device can be used under water. It can write upside-down or at any other angle of position with respect to the writing surface. It will write in extremes of temperature from absolute zero to 500°F and higher; in various atmospheres from 100% humid to bone dry; it is unaffected by dust or other airborne contaminants. The markings cannot be altered or obliterated by erasure or overwriting.

The ultrasonic ball point pen consists of a small generator which develops high frequency oscillations which activate an ultrasonically transducerised pen of size and shape comparable to the conventional pen or pencil.

Applications for this new device include strip and chart recording for industrial and medical measuring instruments where permanence and reliability of marking is critical, cheque-writing machines, high-speed facsimile writing devices and for use on legal, military, or other government documents where protection against alteration or obliteration must be afforded.

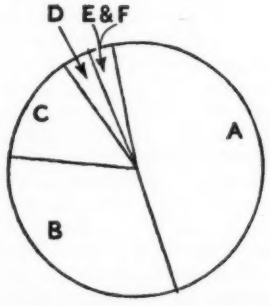
Factory Heating-1

The space heating of factories by electrical means can be achieved in a variety of ways which will be dealt with in the next Data Sheet.

Before deciding on any form of factory space heating—whether by means of electricity or not—it is as well to have clearly in mind all the components of the total annual running cost, and not merely the fuel cost, of the installation.

They are:

- **(A)** The cost of the fuel or the electricity,
- **(B)** Interest and depreciation on the capital cost of the installation,
- **(C)** Labour,
- **(D)** The cost of running auxiliary plant such as fans and pumps,
- **(E)** Maintenance,
- **(F)** Insurance.



In comparing fuel costs it should be borne in mind that electric heat is refined heat and has had all the fuss, bother and dirt of the conversion of fuel into heat taken out at the generating station.

In arriving at the true figures for capital cost and depreciation, maintenance, and insurance, those connected with such items as boilerhouse, chimney, fuel store and access road should be included; labour costs should include such tasks as ash disposal. None of these items occurs when electricity is used, although space will be required for the electric boiler and storage vessels in the case of the type (h) following.

Electricity provides the ideal answer to the requirements of the Clean Air Act, the impact of which has introduced an important new factor during the last few years.

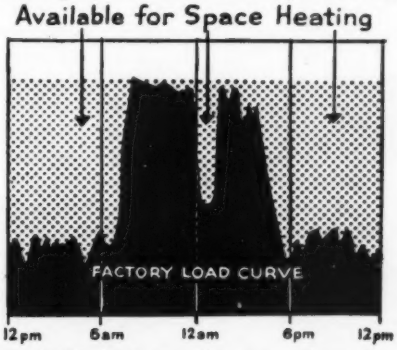
The following list gives the main types into which electric heating installations fall:

- (a) High temperature ("infra-red") overhead heaters operating at near red heat.
- (b) Medium temperature panels operating at surface temperatures of 400° to 600°F.
- (c) Extended surfaced heating in the shape of floorwarming operating at temperatures up to 80°F.
- (d) Oil and water filled radiators.
- (e) Tubular heaters.
- (f) Unit heaters.
- (g) Storage block heaters.
- (h) Electric boilers and water heaters operating in conjunction with hot water radiators or panels either with or without water storage.

All these methods of electric heating can be divided into two distinct classes:

- (a) Those that utilise electricity during "off-peak" hours and store the heat so generated for use at a later period.
- (b) Those that use electricity whenever the heating system is in use (i.e. direct electric heaters).

The use of a heat storage system in a small works on a block tariff takes advantage of the lower tariff offered for an off-peak supply, and in the larger factory on a Maximum Demand tariff means that the heating load will not incur any M.D. charge.



Alternatively there may be cases where the use of direct electric heaters can be integrated with other factory loads in such a way that they are not used during the factory peak periods and will thus incur no additional M.D. charge.

For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2.

Excellent reference books on the industrial and commercial uses of electricity and reprints of articles and papers are available. An example is "Higher Industrial Production with Electricity" (price 8/6 each or 9/- post free).

E.D.A. also have available on free loan in the U.K. a series of films on the industrial uses of electricity. Film and Book catalogues and Publications List sent on request.

1429

Because of the pen's unique ability to operate in all types of atmospheres, there is no limitation on its use in process control instrumentation. Further, since the pen uses no marking fluids, there is no requirement for cleaning, maintenance, or refilling any ink-feed mechanism, one of the difficulties of common strip recording instruments. The fact that the ultrasonic device is unaffected by gravity suggests that the recording mechanism can be mounted in any position as required at installation, whereas gravity-flow ink-fed mechanisms require critically defined positioning.

Ultrasonic Industries contemplates manufacturing the device in styles ranging from desk top decor to industrial and military specifications.

Circle **33** *for further details.*

Monochromatic Light for Checking Surface Flatness

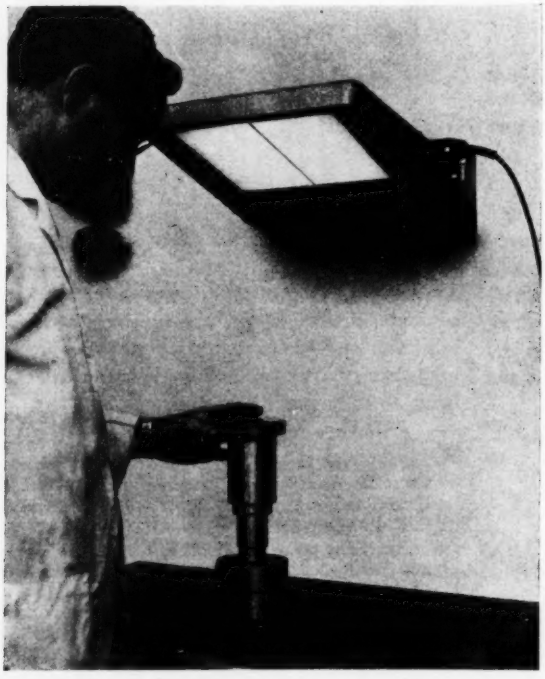
THE technique for checking surface flatness to an accuracy of one millionth of an inch using an optical flat has been facilitated by the introduction of the improved Lapmaster monochromatic light. Payne Products International Ltd. are now marketing this unit.

The new model, which incorporates a high voltage transformer in the light head, may be used on the bench, or fitted to a wall when tall components require examination. The illustration shows an operator testing such a casting. The light source is a series of four helium tubes. In the event of damage, a defective tube may be bridged out of the circuit and the unit used until a replacement is fitted. The powerful monochromatic light can be used to assess widely varying degrees of flatness. No time is lost in reducing air wedge thicknesses above the surface to be tested. This eliminates wear on the optical flat.

Requiring a power supply of 220/240 V, 50/60 c/s, single phase a.c., the light head may be conveniently swivelled and locked in any position in a 200° vertical arc. Individual voltages available to special order.

Circle **34** *for further details.*

Checking surface flatness with the Lapmaster monochromatic light unit



"Sonotek" Flame Detection

FLAME envelopes of all types act as a "mirror" and reflect sound waves. It is believed that this is due to the difference in densities of the flame compared to the surrounding, even hot, gases. A flame detection device based on this effect has been developed by Elcontrol Ltd.

Devices using reflection and transmission methods are under development, and the device can be used with normal flicker circuitry of the "Elcontrol" type together with printed circuit modules.

The device is unaffected by oil and other mists and any reflection from solid surfaces are completely ignored since the final relay circuit responds only to the modulation of the carrier, and even the "steadiest" of flames give a considerable amount of flicker, while solid components in the reflected path give none.

The device is completely insensitive to radiation, flickering or direct, whatever wavelength, and is unaffected by electric sparks. It is also quite insensitive to noise whether from flames or from furnace auxiliaries. No electrode of any type is in contact with the flame. It can be used to pinpoint the position of a flame envelope accurately, and is in effect a type of "echo sounder" for detecting a flame envelope. However rugged or smooth a flame envelope appears a flickering sonic echo is produced. The device is, of course, quite different from the previously used "acoustic" method which detected the actual flame noise which can, of course, be greatly obscured by other noises.

The phenomenon of reflection of sound waves from a flame envelope has not been noted before and is believed to be a basically new contribution to the art of flame detection. All aspects of the system as applied to flame detection are covered by a series of Elcontrol patents pending.

The company is now exploring its applications in many fields as a supplement to their existing range of flame detection units.

Circle **35** *for further details.*

Beryllia-free Mallory 73 Beryllium Copper

ALL Mallory 73 beryllium copper strip up to 0·025 in. thick is now being supplied by Johnson, Matthey with beryllia-free surfaces. This will reduce tool wear without affecting the mechanical properties of the alloy.

Undue tool wear is attributable to the presence of beryllia, a hard and abrasive oxide of beryllium that is formed during the solution heat treatment of the alloy. The oxide is colourless and is not removed by normal cleaning or pickling methods, so that it is often present on material that appears to have a good surface finish.

A new process developed by Johnson, Matthey completely removes beryllia, and the improved material is supplied at no extra cost.

Circle **36** *for further details.*

Transistor Ultrasonic Thickness Gauge

THE transistor ultrasonic thickness gauge, Type 1103, designed by Dawe Instruments, is especially suitable for work which requires rapid and simple non-destructive measurement of material thickness in awkward locations, and to which there is access to one side only. Such applications include corrosion studies and flaw detection on ship hulls and decking, and on piping, tanks and pressure vessels in the oil, chemical and nuclear power industries.

Special features of the Type 1103 are its compact ultra-lightweight design and its direct meter indication of thickness. The material selector switch gives immediate readings with steel, aluminium and copper. Other materials, including most metals, glass, plastics and ceramics can be tested by using the undesignated switch position and calibrating on a known thickness of the material.

In applications where measurement outside the range 0·09 in. to 5 in. is required, or where accuracy greater than 3 to 5% is necessary, the use of alternative instruments is recommended.

The equipment consists of an all-transistor oscillator which generates waves at frequencies variable between 2 and 4 Mc/s. The piezo-electric transducer converts the waveform into mechanical vibrations and transmits them into the workpiece. The vibration frequencies are varied by means of the oscillator tuning dial, and the frequencies at which resonance occurs in the workpiece are found by noting the accompanying increases in the headphone audio signal and in the output meter deflection. In a given material the resonant frequencies are directly related to the thickness, and values from 0·9 in. to 5 in. can be read directly on the large indicating meter.

The standard flat surface transducer is suitable for use on flat, cylindrical and compound curved surfaces down to 2 in. overall diameter or 12 in. internal diameter. Concave transducers are available for use on smaller convex surfaces.

The stable all-transistor oscillator and meter circuits are battery powered. A battery check is provided on the indicating meter, and the typical battery life is 80 hours continuous operation, or 2 to 4 months of normal use.

Circle **37** *for further details.*

Magnoplates

MAGNOPLATES, developed by Millett Levens Ltd., are stick-on labels which use a magnetised powder in a plastic base. The plates can be readily attached to any ferrous surface, and can be produced rigid or flexible, flat or curved, and in any size, colour or design.

In factories, "next operation" or "progress" signs can be easily attached to a machine or to a product during its manufacture, while "danger" and "warning" notices can be used while specific installations are under repair. Storerooms and warehouses can use the labels to indicate the location of stock, libraries to indicate the ever-changing location of classified books, stations to direct passengers or give notice of timetable changes.

The powerful magnetic adhesion enables the plates to be used as price tickets and advertising displays, on canned and tinned products, in shops, stores and supermarkets, as "trade" signs for use on private vehicles by day, or as detour signs or "out-of-order" signs.

Circle **38** *for further details.*

Antimony-clad Nilo-K

JOHNSON, MATTHEY can now offer to manufacturers of semiconductor devices sample quantities of Nilo-K strip clad on each side with 0·5% gold-antimony. It is hoped that production quantities will be available early next year.

The strip is available in widths between $\frac{3}{32}$ in. (2·4 mm) and 2 in. (50·8 mm), in thicknesses down to 0·005 in. (0·13 mm). The thickness of cladding that can be supplied on each face is either 11·5% or 18·75% of the total thickness.

Circle **39** *for further details.*

Resolver Standard

Now available from The Wayne Kerr Laboratories Ltd. is the Gertsch resolver standard (RS-1) which simulates the output of a master resolver.

When driven by a 400 c/s, 26 volt source, the RS-1 produces the two output voltages of a master synchro as its shaft is rotated in 5° increments through 360°.

In addition to high ratio accuracy, 2 seconds of arc, the RS-1 has a low effective series impedance of 0·01 ohm which allows the output to be loaded without any risk of introducing output errors.

Models for frequencies and voltages other than 400 c/s and 26 volts are also available.

Circle **40** *for further details.*

Vibraswitch

THE Vibraswitch is a vibration sensitive device that protects rotating and reciprocating machinery from extensive damage resulting from mechanical malfunction. When the vibration level of a Vibraswitch-protected machine exceeds normal by a pre-selected amount, an internal switch closes, actuating either an audible warning system or a shutdown circuit before costly damage occurs. Failing bearings, broken blades and similar malfunctions cause increased imbalance or high frequency vibration detectable with the Vibraswitch. The Vibraswitch is available with or without electrical re-set and hold-on coils and can be supplied in water-tight or explosion-proof housings.

Circle **41** *for further details.*

Indicating Temperature Controller

THE Foster Instrument Co. Ltd. have developed an indicating temperature controller, fitted with "Resilia" shockproof moving coil and magnet system.

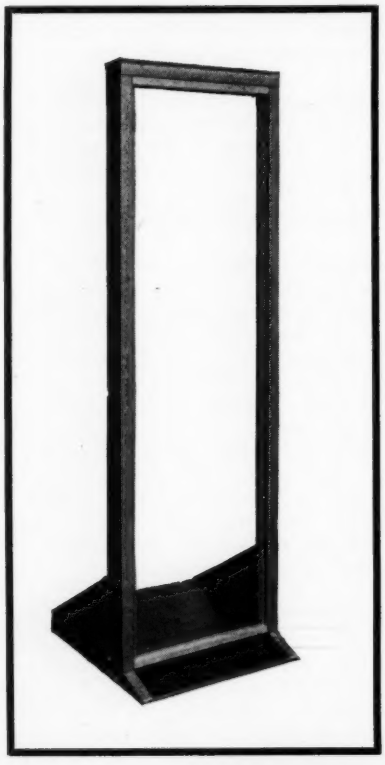
The Type 3556 indicating controller incorporates a photo-sensitive control system which makes it possible for the instrument to operate continuously with a comfortable margin of safety in an ambient temperature of 130°F.

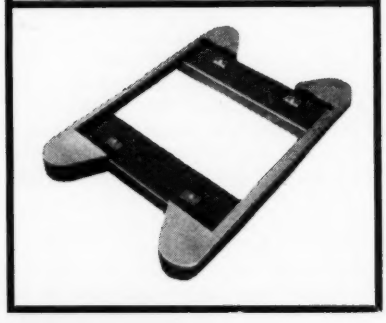
Controllers of this type can therefore be specified with confidence for use under climatic and industrial conditions for which similar instruments employing germanium devices have been unsuitable because of their relatively low upper working temperature limit.

Circle **42** *for further details.*

Circle 354 for further information

NEW!





additions to the IMRAK international series

Send today for full details of these latest additions to the range of International Imraks ; they include :

NEW Open Imrak series, providing an economical panel framework when it is not necessary for the equipment to be enclosed. Available in two widths and four heights.

NEW Mobile bases designed not only for their practicability but also to match the attractive appearance of the raks in this series. Available in four sizes to suit the four basic rak plan sizes.

NEW Extension plinths to provide greater stability particularly when withdrawing heavily loaded chassis or if the equipment tends to make the rak top heavy. Shown here fitted to the Open Imrak but suitable for all raks in this series. Also, as again shown on the Open Imrak, a new range of Filler Plates for blanking off the base in any Imrak.

ALFRED IMHOF LIMITED Dept. H 11
Ashley Works Cowley Mill Road Uxbridge Middlesex England
Telephone Uxbridge 37123 Telex 24177 Telegrams Imcase-Uxbridge-Telex

IMHOFS AGENTS OVERSEAS
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Belgium: Rogelec, Ghent
Cyprus: L. Piandjian, Nicosia
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Italy: Stuart Culley, Milan
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Morocco: E.G.E.E., Paris (19)
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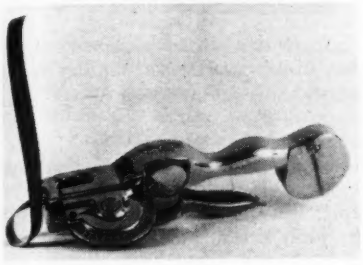
Portugal: Projectos e Construções Lda, Lisbon
South Africa: Switchcraft (Pty) Limited, Johannesburg
Sweden: Electronlund AB, Malmo I
Switzerland: Walter Blum, Zurich 2/39
Tunisia: E.G.E.E., Paris (19)
U.S.A.: Bud Radio Inc, Cleveland 3, Ohio
British Guiana: Davsons Caribbean Agencies Ltd, Georgetown

Hand Embossing Tool

THE Hellermann Dymo hand embossing tool is now available in kit form, which will enable labels to be produced either horizontally or vertically.

The Dymo tool, which embosses labels on a wide range of metallic and various colour p.v.c. tapes, can now be supplied with two separate dies that can be easily interchanged.



Dymo-mite embossing tool

Dymo tapes are available either with or without adhesive backing.

Circle **43** *for further details.*

Displacement Indicator

THE General Controls "Genetrol" displacement indicator, Series TM-1, consists of a linearised indicator unit and a transmitting potentiometer. The indicator unit can be battery operated for intermittent reading or mains operated for continuous indication.

The transmitter can be any one of the General Controls range of precision potentiometers, either single turn up to 358°, multi-turn up to 25 turns or linear.

Some of the uses to which this equipment can be put are:

1. Control valve position indicator
2. Position indicator for the control gear of pumps, turbines, forced and induced draught fan, etc.
3. Shaft position indicator.

Circle **44** *for further details.*

P.T.F.E. Pipe Thread Sealing Tape

TURNER BROTHERS ASBESTOS CO. LTD. are manufacturing a p.t.f.e. pipe thread sealing tape. This unsintered tape is supplied as a continuous ribbon ½ in. wide on metal dispensers in lengths of 20 ft, 30 ft or 40 ft. Breaking of the connection is easily accomplished, even after a long period of time.

The plasticity of the material ensures that it conforms exactly to the contours of the thread, resulting in a perfect seal against pressures of many thousands of lb/in². It is also unaffected by temperatures ranging from −100 to + 300° C, is chemically inert and will not cause contamination of the liquid being handled. Turners' p.t.f.e. tape is impervious to water, steam and most corrosive liquids and gases, and is unaffected by ageing or weathering.

Circle **45** *for further details.*

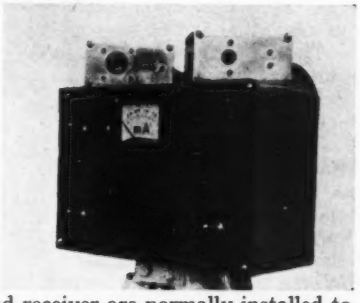
Sheer Register Controller

A PHOTO-ELECTRONIC appliance designed specifically to ensure accurately cut lengths on all types of roll fed converting machines is now being manufactured by Hird-Brown Ltd. It can control any feed mechanism by a register mark on the moving web of material to trigger the control circuit.

Known as the Paton Mark IV sheer register control, the device is a development of the Paton Mark III, an improved electronic circuit which gives greater stability and reliability. Another improvement is that the setting-up procedure is much easier, and it can be fitted to any existing machinery.

The Paton Mark IV comprises a control-amplifier unit, 10 × 6 × 4 in., and a light projector and a photocell receiver, each 3½ × 2 × 1¾ in. Each unit can be mounted in any way suitable to the circumstances but generally by drilling and bolting to brackets. The three components are interconnected by cable and connected to a 110/200/250 volts single phase, 50 or 60 c/s supply. The power consumption is about 60 watts.

The projector and receiver can be used for either transmitted or reflected light, so that they can be placed on opposite sides of a transparent material or on the same side of an opaque material. They can also be adjusted to be sensitive to either an increase or a decrease in illumination, so that a white mark can be used on a dark background as a register key as well as a dark mark on a light or transparent background. A transparent mark on an opaque material can also be used. The mark can be of any colour and should be more than 1/16 in. wide.



Paton Mark IV sheer register controller

The projector and receiver are normally installed to give a beam length of three inches, but special units can be supplied to meet unusual requirements.

The control unit, which is normally installed at any convenient point within 12 feet of the projector and receiver, is equipped with a full control panel comprising an on/off switch, a re-set switch, a meter to monitor the lights on the photocell, a sensitivity control, a brilliance control and an increase/decrease light switch. A 5-amp double pole double throw relay is also provided.

The price of the complete unit is £45.

Circle **46** *for further details.*

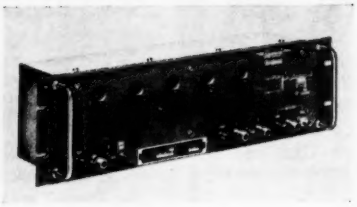
Heat Sink

ANTEX have now placed on the market a heat sink for use when soldering transistors with their Antex precision soldering iron.

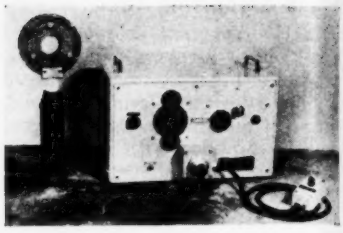
The retail price is 1s. 4d. subject to usual trade discounts.

Circle **47** *for further details.*

◀ *Direct view storage tube*



Ratio bridge



Electronic pin hole detector

Dual-gun Storage Tube for Satellite and Missile Tracking

A DUAL-GUN 10 inch storage tube (Storatron) specifically adaptable to missile and satellite tracking, manufactured by the Electronic Tube Division, Allen B. DuMont Laboratories, is being introduced by Aveley Electric Ltd. Designated Type K2087, the Storatron features excellent tracking accuracy between guns and raster orthogonality without resort to on-axis writing. It utilises a patented DuMont gun structure to achieve deflection linearity within 1% (no deflection plate current).

Advantages of its dual-guns are the ability to track from two separate antennas or two angles or points. Storage time of the tube is from 3 to 10 minutes. The tube is adaptable to TV frequencies and can freeze TV presentations with excellent light output. Any action can be frozen and observed while the action is still taking place.

Writing speed of the K2087 is 200,000 in/s at 40 lines/in. resolution and 50 foot lamberts light output.

The deflection system is unaffected by the viewing gun current and is compatible with high impedance deflection circuits.

Circle **48** *for further details.*

Ratio Bridge

A RATIO bridge designed for operation at frequencies exceeding 10 kc/s and combining in one instrument a precision ratio transformer and an electrostatically shielded bridge transformer is now available from The Wayne Kerr Laboratories Ltd.

Only an external null detector is needed with this instrument (designated RB-105) to make precise measurements of ratios up to 1·1111 with an accuracy of 0·0025%.

The unit has an input impedance of 300 kΩ at 10 kc/s and the interwinding capacity of the bridge transformer is less than 1 μμF. Five decades of transformer switching are provided with switching transient suppression, in-line switching and readout.

Full frequency range of the RB-105 is from 300 c/s to 20 kc/s, resolution is in 0·001% steps and terminal linearity is 0·0025%.

The unit is supplied for mounting in a standard 19 × 5¼ in. rack with terminal connections on the front and rear panels.

Circle **49** *for further details.*

Pin Hole Detector For Insulated Pipes

WITTON ELECTRONICS LTD. have recently manufactured an electronic pin hole detector, suitable for inspecting the insulating coating of metal pipes, either during manufacture or in the field.

The equipment comprises an electronic unit, suitable for operation from mains supply or 12 V battery, and a scanning head.

When the scanning head is moved by the operator along the pipe any fault or pin hole in the insulated coating is located by a non-lethal high voltage discharge, which gives an audible and illuminated signal on the control unit.

The scanning head can be supplied with interchangeable or split rings to suit various sizes of pipe.

Circle **50** *for further details.*

Neutron Gamma Monitor

PLESSEY NUCLEONICS LTD. has introduced a portable neutron/gamma monitor, Mark 2NRM, in which measurement is made by scintillation counter techniques. Separate detector probes are used with appropriate phosphors for fast neutron, thermal neutron and gamma radiation. Indication is on a meter directly calibrated in milli-rem/h, with an additional facility of dose integration at very low neutron dose rates. The monitor has been designed to Admiralty specifications for measurement of the biological dose from neutron and gamma radiation in the vicinity of a propulsion reactor.

Ranges Thermal neutrons:	0 to 0·03
(1 mrem/h ≡ 250 n/cm²/s)	0 to 0·1
	0 to 0·3
	0 to 1
	0 to 3
	0 to 30 mrem/h

Measurements may be made in the presence of gamma radiation of 100 times the equivalent dose rate (up to a maximum of 300 mr/h).

Fast neutrons:	0 to 1
(1 mrem/h ≡ 4 n/cm²/s)	0 to 3
	0 to 30
	0 to 300 mrem/h

Measurement may be made on the two most sensitive ranges in the presence of gamma radiation of 100 times the equivalent dose rate. The effect of higher dose rates is dependent on energy; at 6 MeV gamma breakthrough begins at a few hundred mr/h.

Response is within ±20% over the fast neutron energy range 2 to 10 MeV.

Gamma radiation:	0 to 0·3
	0 to 1
	0 to 3
	0 to 30
	0 to 300 mrem/h

The gamma radiation which the equipment will be required to measure in the application for which it has been designed is predominantly in the 4 to 5 MeV region, but the range 0·1 to 6 MeV is covered.

The indicator unit contains the battery pack and electronic circuits. Except for one electrometer pentode, all circuits use transistors.

Indication is on a 3½ in. scale length moving-coil meter. In addition to the direct calibration in dose rate there is a red mark to indicate 100 counts on an "integrate" range, so that very low counting rates can be measured within a statistical accuracy of 10%.

The equipment is designed to meet general British inter-service requirements, and to withstand climatic and durability testing to specification K114G. The indicator unit and the three types of scintillation probe are all sealed and desiccated.

The indicator unit measures 12 × 8 × 7 in. and weighs 11 lb.

The probes are of cylindrical construction with overall dimensions (varying slightly for the different applications) approximately: diameter 3 in; length 11 in. Weights range from 3½ to 5 lb.

The power pack contains 16 Mallory cells Type RM 12R, series connected in a single battery. Life 50 hours. Battery condition can be checked on the indicator meter.

The equipment is capable of withstanding temperatures in the range 0 to 55°C, but accuracy is affected if probe temperature exceeds 40°C.

Circle **51** *for further details.*

Coaxial Ratio Transformers

A RANGE of coaxial ratio transformers—the CRT-1, 2, 3 and 4—with indicated ratio accuracies of from 0·01% to 0·001% between 50 and 10,000 c/s is now available from The Wayne Kerr Laboratories Ltd.

Common features of all four models are high input impedance, terminal linearity of 0·001%, continuous resolution by means of in-line concentric dials, very low phase shift and an input inductance of 150 H.

Models CRT-1 and CRT-2 are designed specifically for restricted panel space—five units being easily mountable on a 3½ × 19 in. panel. The CRT-1 offers six-place digital readout (with a three decade ratio transformer and a ten-turn interpolating potentiometer) whilst the CRT-2 is identical, except for a single-turn potentiometer, and provides five-place read-out.

The CRT-3 and CRT-4 are subminiature types designed particularly for applications involving small panel areas with minimum depth and requiring units to meet military specifications. In spite of their small size, both the CRT-3 and 4 have an accuracy of 0·001%, the CRT-3 giving five-place resolution and the CRT-4 six-place resolution.

Weight of the CRT-1, 2, 3, and 4 is approximately 7 lb each.

Circle **52** *for further details.*

Counter Units

INCORPORATING an electro-mechanical 6-digit counter and mains operated power supply, these Pentechnique counter units have been designed to operate directly from a transistorised magnetic transducer.

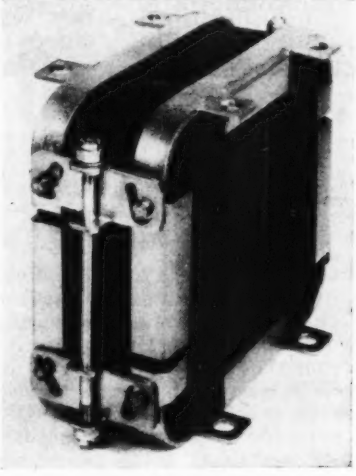
With a maximum counting rate in excess of 20 per second (1,200 per minute), they can be used for counting shaft revolutions, reciprocating motions and other machine operations. Where linear motion can be translated into rotary motion, these units can be used for length measurement.

If mounting space for the transducer is limited, standard small magnetic transducers can be used and in this case the necessary pulse-shaping circuits are incorporated in the counter unit with the power supply. This type of counter unit can also be supplied to operate from switch contacts or photo-electric pick-ups.

Both versions are fitted with mains switches and neon warning lights and, as semiconductor devices are used throughout, no warm-up time is necessary.

Modified versions of these units can be supplied, if required, including the provision of alternative types of counter, omission of mains switch and/or warning light and power supplies for different mains voltages. Where a suitable 12 volt or 24 volt d.c. supply is available the mains power supply can be omitted. Prices range from £23 8s. 0d. upwards.

Circle **53** *for further details.*



C-core transformer clamp

C-core Transformer Clamp

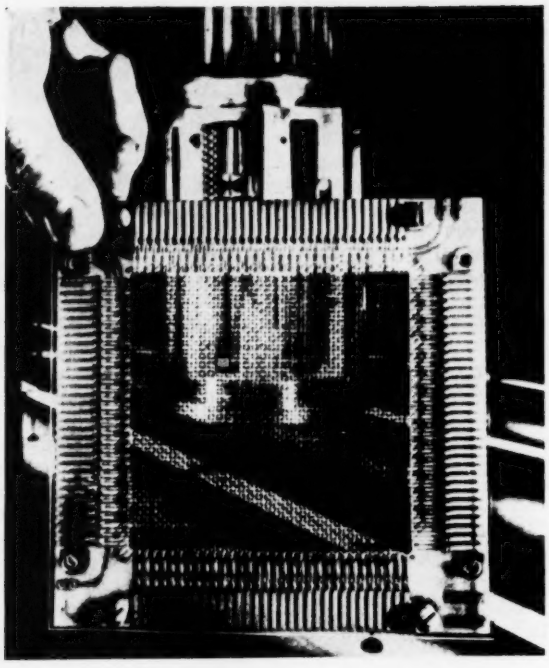
THE approved method of assembly of C-cores in shell-type transformers is to use a steel band which is applied with a known tension, and then solder-sealed. Another method commonly used for larger C-cores employs a screw-type band, but whichever method is adopted clamping frames must be used to accommodate a terminal board, and to provide mounting facilities.

M.K.S. Nucleonics Ltd. have patented a dual-purpose clamping frame having significant advantages over those types at present available, these advantages being:

(a) Elimination of the banding of the cores
(b) Automatic location and lining up of the C-cores
(c) Low assembly costs
(d) Small number of separate components.

For horizontal mounting with Inter-Service fixing centres an inexpensive and simple adaptor plate is available, as are coil shrouding plates.

Circle **54** *for further details.*



Core memory plane

Solid State II Computer

THE Univac Solid State II computer features both magnetic core and drum memory.

Two tape synchronisers and up to 20 tape servos enable simultaneous read-write, read-read and write-write operations. The Univac Solid State II is equally adaptable to punched card processing. Highly versatile, the system will accommodate 80 or 90 column cards, and plastic and metallic magnetic tape. In punched card processing, reading proceeds up to 600 cards a minute; punching, 150 cards per minute; printing, 600 lines per minute—all operations being carried on simultaneously.

Information stored in the core memory can be assessed at the rate of 1·5 μs per digit. To move data between drum and core storage in the same access time per digit, up to 2,200 digits in a single operation, a new variable multi-word transfer feature is available.

Other features of the computer are:
14,080 digits of core; 28,600 to 96,800 digits of fast drum memory (17,670 rev/min); up to two tape synchronisers; 20 tape servos; 9 index registers; multi-word transfer: drum to core—core to drum; full alpha-numeric compare.

Circle **55** *for further details.*

P-N-P Junction Transistors

A NEW range of silicon p-n-p junction transistors has been introduced by Brush Crystal Co. Ltd. The range, known as the OC700 series, consists of five transistors designed to meet the needs of most low frequency applications. These silicon transistors can be used in many applications for which germanium transistors were previously necessary.

The company is also producing a new range of Zener diodes, re-grouped into preferred voltages and considerably reduced in price to make them the most competitive diodes available.

Circle **56** *for further details.*

Delay Lines

COSSOR RADAR & ELECTRONICS LTD.'s existing range of magnetostriction delay lines has been extended. Delay lines now available permit dynamic storage of pulse information for periods from 5 microseconds to 1·5 milliseconds.

The lines consist basically of a nickel tube, the ends of which are terminated in matched p.v.c. loads. Transducers, in the form of encapsulated ferrite cored coils, are threaded on to the nickel tube. When a pulse is applied to the input transducer, a magnetic field pulse is produced along the axis of the nickel tube. This, in turn, promotes a strain pulse which is then propagated in both directions along the tube at a velocity equal to the speed of sound in nickel. As this strain pulse passes through the pick-off coil, an output pulse is generated. By varying the distance between the input and output transducers adjustment of delay times can be made in circuit without disturbing the unit.

If required, a number of pick-off coils can be arranged along the delay line. In this way several output pulses can be produced at discrete time intervals after the occurrence of a single input pulse. The number of output transducers that can be threaded on to a particular delay line is limited only by the physical length of the nickel tube and the longitudinal dimensions of the transducers. The lines thus find useful application in the production of binary coding and decoding sequences, selective gating systems, sequential calling devices, shift-registration, series to parallel and/or parallel to series converters.

The complete delay lines can be supplied mounted in metal containers which, in addition to protecting the unit, provide a shield between the delay line and adjacent circuits. In addition to a number of standard ranges, Cossor magnetostriction delay lines can be supplied with delay times adjusted to meet users' individual requirements.

Circle **57** *for further details.*

Test Jack

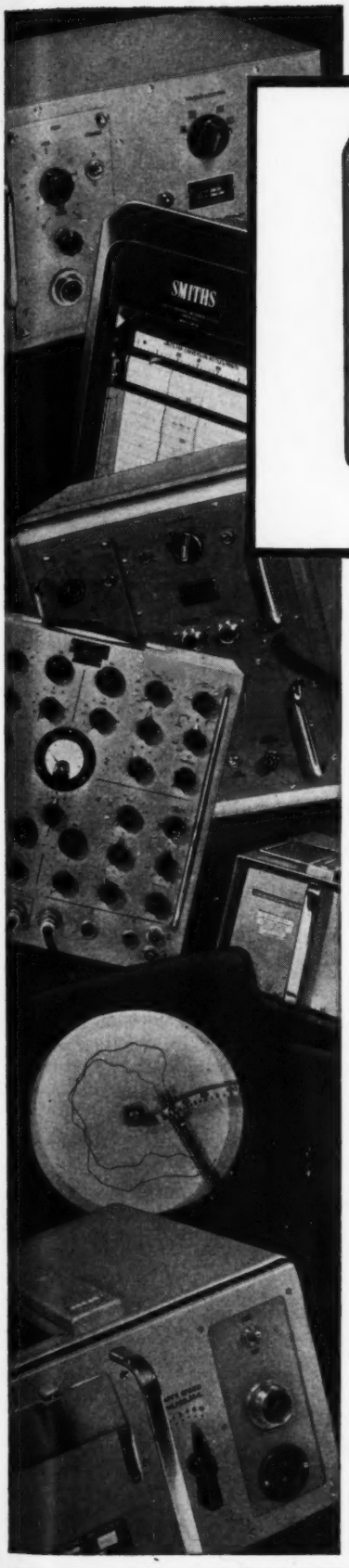
SEALECTRO CORPORATION have available a p.t.f.e. insulated test jack designed for assemblies where space is at a premium. The new unit is designated as Type SKT-37.

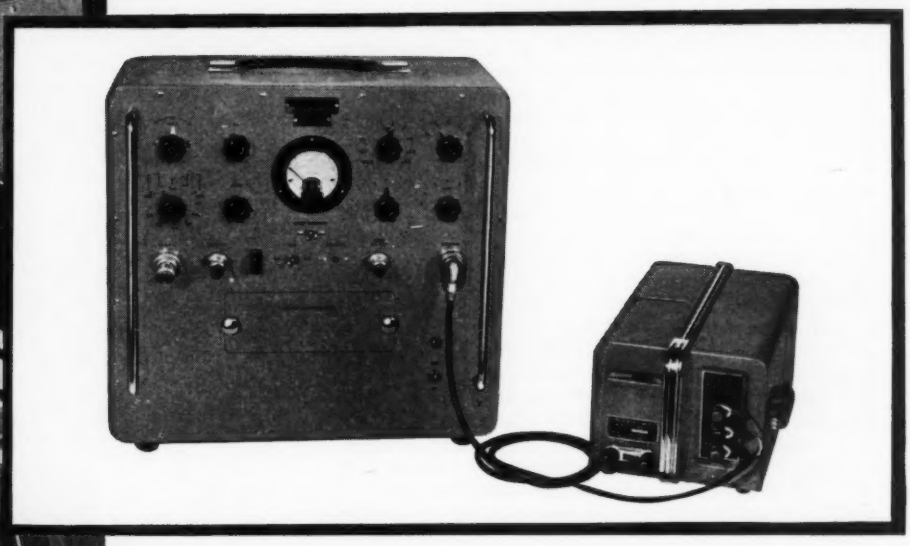
The Sealectro "Press-Fit" SKT-37 receives a 0·090 in. diameter probe, 0·140 in. long. Overall diameter, above the chassis, is only 0·218 in. while overall height, including mounting shoulder and soldering stud, is only 0·340 in. The new test jack has a 0·170 in. diameter body for the through-chassis mounting.

The electrical contact for the test probe is of beryllium copper, providing positive, low-resistance conductivity for accurate take-off measurements.

Circle **58** *for further details.*

Circle 355 for further information





SMITHS recording

Specialisation in high-speed recording techniques enables SMITHS Industrial Division to offer a wide range of instruments for the instantaneous and permanent recording of strain, displacement, acceleration, vibration, speed, temperature, time, voltage, current and many other variables. Illustrated here is a SMITHS Single Channel Dynamic Strain Recorder. This equipment, comprising a bridge and amplifier unit and a high-speed single channel pen recorder, is suitable for operation with resistance, inductance and capacitance pick-up devices. Sensitivity is such that a 1½ cm. deflection can be traced for a .005% change of resistance in a 2,000 ohms pick-up. If you have a recording problem, we will gladly send a Technical Representative to give you fullest details of SMITHS recording resources.

SMITHS range of recording equipment includes: Dynamic Strain Recorders; Potentiometric Recorders; Cage Landing Speed Recorders; High Speed Pen Recorders; Single and Multi-Channel Recorders; Multiline Recorders; Circular Chart Recorders.

SMITHS INDUSTRIAL DIVISION

The Industrial Division of **S. Smith & Sons (England) Ltd**

Kelvin House, Wembley Park Drive, Wembley, Middx. Wembley 8888

SID DRI

Automatic Printed Circuit Drill

A FULLY automatic printed circuit drill, specifically designed for fast and economical drilling of component fixing holes in printed circuit boards, has now been introduced by Ferranti Ltd. The new machine, already in limited quantity production at the company's Edinburgh factory, will cost £3,600, and will be available on six months' delivery.

As the size and capacity of transistorised digital computers continues to increase, production engineers are becoming more and more aware of the need to find shortcuts in producing the large number of printed circuit boards required for these machines. The printed circuit drill has been developed with quantity production in mind and in the knowledge that package production can also take up valuable time—particularly if a prototype machine or limited production run is planned.

Basically, the machine consists of two drilling heads allowing either tandem or single spindle working; an hydraulically-operated co-ordinate table carrying the printed circuit boards which is automatically moved to bring the board hole centres in turn below the drills; and a control system for the drilling action and table movement which enables the machine to work unattended except for loading and unloading.

The drilling table, which covers an area of 20 × 14 in., is moved parallel with or at right angles to the front of the machine by two hydraulic jacks. Accurate positioning of hole centres under the drills is carried out in two consecutive stages.

Firstly, rough positioning is achieved by the use of a perforated template and photo-electric cell.

Secondly, accurate positioning is produced by a mechanical indexing system using the meshing of a half nut and precision rack. A positional accuracy of ±0·001 in. can be obtained and repeatability is within 0·001 in.

Drilling is carried out to a grid system, the holes being drilled in a systematic pattern of rows and columns. The basic spacing between rows of the grid system is determined by the pitch of the thread of the precision rack associated with row alignment. A typical pitch is 20 threads per inch giving a spacing between rows of 0·050 in. or multiples thereof. A similar precision rack is used for column alignment. It should be noted that the basic spacing need not be the same for rows and columns.

The perforated template is mounted on an extension of the drilling table and whenever a hole in the drilling area of the template coincides with the light beam, the photo-electric cell is stimulated and provides a signal to the machine's control system. This signal initiates: (1) The cut-off of the oil flow to the hydraulic jacks, stopping the drilling table; (2) The application of oil to the half nut mechanism to mesh the half nut with the precision rack, thereby accurately locating the table and locking it in position; (3) The drilling action by switching electrical power to the drills.

On completion of the drilling action, a signal from the drilling head is fed to the control system to release the half nut from the rack and to re-start the flow of oil to the jacks which move the table. This process is then repeated for the next hole in the template.

As mentioned previously, the pattern of holes is systematically drilled row by row. When a row is completed, the drilling table moves to bring the adjacent row into line with the drilling heads. Movement of the drilling table to bring the next row into line is controlled by two columns of row marker holes in the template. Each row of the drilling pattern has an associated row marker hole. These holes stimulate the photo-electric cell and the resulting signal to the control system causes the table to move up to the next row and along that row. When the last hole is drilled, the drilling table returns to its start position and stops.

The machine can accommodate a single stack—up to $\frac{3}{8}$ in. deep—of one or more printed circuit boards with dimensions of up to $12\frac{1}{2} \times 18$ in. with maximum drilling dimensions of $11\frac{1}{2} \times 17\frac{1}{2}$ in. Alternatively, it can accommodate two stacks of identical boards for simultaneous drilling, each stack up to $\frac{3}{8}$ in. deep and one or more boards per stack, each with dimensions up to $12\frac{1}{2} \times 8\frac{1}{2}$ in. with maximum drilling dimensions per board of $11\frac{1}{2} \times 7\frac{1}{4}$ in.

The rate of output of completed boards is dependent on the pattern of holes to be drilled and the number and thickness of boards forming the stack.

The machine, which weighs about 18 cwt, is suitable for use from a 3-phase a.c. mains supply, the loading being approximately 1·5 kVA. Installation is relatively simple as no special levelling is required. The area of the base casting is 49 × 42 in. and the height from floor to table is 41 in. Chuck capacity is 0 - $\frac{5}{32}$ in. and the maximum drilling thickness in synthetic resin bonded paper is $\frac{3}{8}$ in. The Dumore Series 20 drill heads incorporate a series type motor having a chuck on one end of the shaft and a 3-blade vane type compressor on the other end which provides the necessary compressed air for feed thrust.

The speed of the spindle is automatically governed by the drill size and the work material. The larger drills offer more rotational resistance which slows down the series motor, thus providing automatically the proper speed for a given drill. Speed is governed primarily by the air pressure regulator setting, the higher pressures providing more thrust and therefore a higher feed rate.

An important feature of the machine is that the operating and control mechanisms are completely shrouded against the ingress of drilling swarf. Maintenance is confined to the occasional topping up of the hydraulic oil reservoir about once every six months.

Circle **59** *for further details.*

12-way Terminal Blocks

THE flexible polythene 12-way terminal blocks, from Metway Electrical Industries, will be marketed in four sizes—5, 10, 20 and 30 amp. The colour will be silver-grey and all metal parts will be plated.

These blocks are known as the "Captiveway", because once the screws are fixed, they become captive by means of three internal projections. The list prices, subject to quantity discounts, will be as follows:

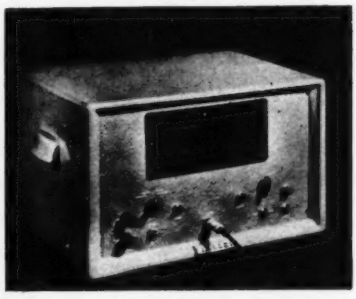
List No. 34201	5 amp	2/6 per 12-way block
List No. 34203	10 amp	3/9 per 12-way block
List No. 34205	20 amp	7/– per 12-way block
List No. 34207	30 amp	8/6 per 12-way block

Circle **60** *for further details.*

5-Digit Volt-ohm Meter

A NEW addition to the Ferranti range of digital instruments is the Type D201 5-digit volt-ohm meter. This instrument, which makes extensive use of semiconductor elements, has been designed to measure d.c. voltage and resistance over a wide range to an accuracy of better than 0·03% of reading or ±3 digits, whichever is the greater.

Voltage range is 0·0001 to 1,000·0 V d.c. and the resistance range 0·01 ohms to 1,299·8 k ohms. The ranging is automatic on both inputs except for the most sensitive range in each instance, which is selected by a " divide by 10 " switch. D.C. current can be measured from full scale readings of 1·9999 μA to 1·9999 mA after slight modification to the instrument. The conversion time is normally 250 milliseconds—irrespective of reading—and the input impedance is 4·44 megohms on all ranges, although this can be increased to 10 megohms if required.



5 digit volt-ohm meter

Print-out facilities are available and a parallel output may be fed to a suitable adaptor from the read-out sockets. Other outputs may be taken from the instrument, either as 28 volt positive pulses from each decade, or in binary coded form. When the instrument is balanced, a command signal to print may be obtained. Servicing of the instrument has been simplified by using detachable sub-units which are easily maintained, printed circuit cards being used for the transistor circuitry.

The instrument is housed in a cabinet measuring 20 × 15 × 14 in. and weighs 35 lb approximately. A rack-mounted version is also available.

Circle **61** *for further details.*

Vacuum Tweezer System

L. E. SIMMONDS LTD. have been appointed sole concessionaires in the United Kingdom for the vacuum tweezer system V-100 made by The Vacuum Tweezer Co., New Jersey, U.S.A.

The system, which is portable and self-contained, operates from a.c. mains supply and consists of an electro-magnetic vacuum generator and a vacuum pencil with stainless steel pick-up tip. The generator is provided with an adjustable pressure control. The vacuum pencil is similar in size to a propelling pencil, and is connected to the generator by flexible tubing which incorporates a dirt filter. Various shapes and sizes of pick-up tip are provided.

Operation is easier, and less likely to damage the component being picked up, than any mechanical handling arrangement. To hold a component the operator simply touches its surface with the pick-up tip of the pencil, at the same time covering a small opening in the pencil body to maintain vacuum pressure. Uncovering the opening will release the pressure and the component.

Circle **62** *for further details.*

High Stability Resistor

THE Electrosil N. type resistor is of metal oxide film on optical quality glass construction. Life testing of 1,500 resistors over a period of three and a half years at loadings up to 140% of rated wattage showed resistance changes of less than 1%. Failure tests over this period revealed no catastrophic failures and, assuming a ±3% resistance change as a failure, the actual rate was less than 0·000083 per 1,000 resistors.

The N. type resistor is designed to meet DEF 5114 and advance type approval has already been granted to part of the range, which betters the specification in almost every respect.

With a noise level of less than 0·015 μV/V coupled with outstanding long-term stability, N. type resistors offer a low priced answer to designers of all types of equipment.

A full range of values is available.

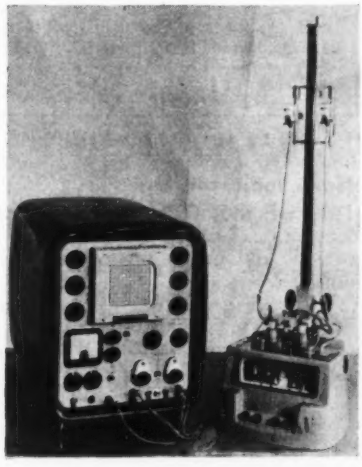
Circle **63** *for further details.*

Davis Differential Cathode Ray Polarograph

THE Davis differential cathode ray polarograph is the improved commercial version of the original differential cathode ray polarograph designed by H. M. Davis at U.K.A.E.A., Woolwich, and recently substantially redesigned by him at Southern Analytical Ltd., in respect of signal/noise ratio, drift and frequency response. The reduction in noise level greatly facilitates measurements at high sensitivities, and the increased amplifier bandwidth is particularly valuable in the study of reductions or oxidations occurring at closely adjacent potentials, when the first or second time derivative of the cell current waveform is required to obtain maximum resolution.

For the first time reversed potential sweep facilities are included on all four modes of operation; subtractive, comparative, derivative and single cell operation.

Circle **64** *for further details.*



Davis differential cathode ray polarograph

Elapsed Time Indicators

THE new elapsed time indicator, manufactured by Cass & Phillip Ltd., incorporates a voltage stabilising device based on a Zener diode.

The elapsed time indicator mechanism is operated by a 6 V d.c. supply at 30 mA ± 10% instantaneous and the voltage stabilising system ensures that this voltage is maintained to the operating coil within tolerances, in spite of wide fluctuations in the supply voltage.

An instant starting and stopping device is incorporated in the instrument. The complete mechanism including the gear train is suspended on four leaf springs spaced on 90° arcs. The mechanism is then inserted in a polythene case, the leaf springs being located in grooves moulded in the case. This assembly is then installed in a steel outer case and electrical contact is made through insulated terminals in the rear.

Clever design has enabled the voltage stabilising system to be incorporated without increasing the physical dimensions of the instrument.

Instruments are available, if required, fitted into a cast aluminium case complete with protective front cover and anti-vibration mountings according to type of application and requirements of the user.

Circle **65** *for further details.*

Silicon Variable Capacity Diode

A NEW device designed to take the place of conventional trimmers and even gang condensers has been introduced by Brush Crystal Co. Ltd.

It is a silicon variable capacity diode. The capacitance depends on the reverse bias voltage applied to the diode.

	BA110	BA111	
Reverse capacity C V_R = 2 V f = 30 Mc/s	10 ± 2	55 ± 10	pF
Series resistance R_S V_R = 2 V f = 30 Mc/s	1·8	1	Ω
Forward volt drop V_F at I_F = 60 mA	<0·85	<0·8	V
Reverse breakdown voltage BV_R	>50	>30	V
Leakage current I_R V_R = 10 V	<50	<100	nA
Loss factor at 100 Mc/s tan δ	10^{-2}	3×10^{-2}	—

Circle **66** *for further details.*

Neon Indicator Units

THE SGF and SGFF are neon indicator units designed to operate directly on a.c. supply lines. The lamp, resistor and holder are combined into one packaged unit.

The unit is mounted by pushing into a circular hole; it is locked in position by 3 radial steel springs. Connection can be made with AMP-Faston type connectors (screw connection or solder can be used if preferred).

The range of colours available are: clear, opal, red, green, yellow and blue.

They have a life of over 50,000 hours.

The SGF has a curved face and the SGFF a flat face. Standard voltage is 220 V a.c.

These neon indicator units are available from Walmore Electronics Ltd.

Circle **67** *for further details.*

Batching and Indicating Counter

THE electromagnetic counter, Series P43, recently introduced by Lancashire Dynamo Electronic Products Ltd., has facilities for predetermined batch operation combined with an indication of total count. The Series P43 is designed to enable the operator to manually pre-set any batch from 999,999 downward and when the set number is reached an internal switch is actuated. Manual and electrical re-set facilities are provided and the units are designed for counting speeds of up to 1,500 impulses per minute.

The Series P43 counters are based on the reliable Series F43 counters, which the suppliers have marketed for some time, and similar methods of construction are used. These constructional techniques include plug-in facilities, interlocking dove-tailed castings for building up blocks of counters, and alternative flush panel and proud mounting arrangements.

The Series P43 counters are designed for a range of supply voltages from 6 to 220 volts, suitable power supply units being included in the wide range of accessories which are available.

Circle **68** *for further details.*

Industrial Closed-circuit Television

WOLSEY ELECTRONICS LTD. have been appointed distributors of Grundig closed-circuit television in the British Isles.

Modern industrial closed-circuit television works on the same principles as broadcast television. The main operational difference being that it uses a co-axial cable for linking the monitor and the camera.

The Grundig closed-circuit television unit comprises: a small size light-weight television camera; a power unit; a monitor; and ancillary equipment for special purposes and applications are also available.

It is possible to use any of a large range of lenses and other various mechanisms for focusing, lens control, tilting and swivelling the camera, this includes the constant focus zoom type lens. Power units can be connected to any source of mains supply, the monitor can be a standard television receiver.

The Grundig Type FA "40" television camera is available for use with 405 or 625 line receivers and can be modified for tele/ciné and may also be supplied with a video output only. A Type FM T40 sound modulator is also available.

An important feature of the Grundig FA "40" camera is that, unlike most vidicon type cameras, this model has no external controls other than an on/off switch, so that once the camera has been set up by a semi-skilled operator no further adjustments are necessary for a considerable period. The circuitry is so designed that normal variation in light-level is compensated for by the camera system. Whilst any great light-level variation may be controlled in the normal manner by means of the iris in the lens.

Circle **69** *for further details.*

Voltage Dividing Resistance Box

THIS unit, available from Lionmount & Co. Ltd., is designed on the Kelvin-Varley principle and, with four decades, will accurately subdivide an input into 10,000 parts.

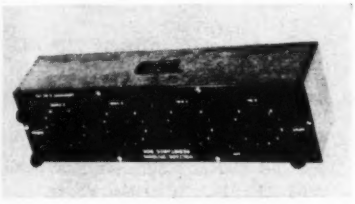
When supplied from a known stabilised voltage, it can be used, in conjunction with a nulling device, to determine an unknown voltage, or to provide a controlled input to a servo-system. With one other known resistor it will make up three of the arms of a Wheatstone Bridge.

Types

PD2—10,000 ohms input resistance, 220 V r.m.s. input max.

PD3—100,000 ohms input resistance, 300 V r.m.s. input max.

Type PD2 can be fitted with a multiplier giving a further $\times 0{\cdot}1$ and $\times 0{\cdot}01$ reduction in output. This will enable microvolt signals to be compared.



Digital dividing resistance box

The resistors are non-inductively wire wound on ceramic formers with a low temperature coefficient alloy wire. They are temperature stabilised and encapsulated, and have an accuracy of 0·2% at 20°C when measured on direct current.

Well tried conventional switches are used, having a positive step action and giving a long and trouble-free life.

The instrument is of rigid construction having a solid mahogany case with a thick stove-enamelled panel. The knobs traverse markings of clear large white figures. An aluminium liner is fitted for screening purposes. The size is 14 × 4 × 4¼ in. overall (35·5 × 10·2 × 10·8 cm) and the weight is 3 lb 10 oz (1·73 kg).

Circle **70** *for further details.*

Microseal Diodes

THE basic MICROSEAL configuration developed by Hughes International (U.K.) Ltd. is that of a small, rugged ceramic cylinder, 0·062 inches in diameter. The ends are capped with round metal plates to provide a total thickness of 0·030 inches. The metal and ceramic are brazed together to form an hermetically tight container that has survived every environmental and time test. The reliability standards set for the new MICROSEAL units are actually higher than those for established Hughes semiconductor units.

The semiconductor die is the only active element in a transistor yet, in a standard "can" package, it occupies only 1/3000th of the total volume. The rest of the space is required for mounting and connecting elements, and to enable the manufacturer to provide a true hermetic seal around the assembly (even the slightest trace of moisture or atmospheric contamination will degrade the semiconductor performance).

The MICROSEAL technique eliminates only non-contributing space and weight. To provide an hermetic shield in minimum space, the MICROSEAL structure combines an impervious ceramic shell with corrosion-proof metal caps, brazed with precious metal. The whole process will eventually be accomplished by non-manual techniques, promising significant savings in component costs.

Since the active semiconductor element within the package is essentially unchanged, almost every diode and transistor produced by Hughes Semiconductor will be available in the MICROSEAL configuration. Only the physical form of a microcircuit is changed, not its electrical values or design. In certain instances, characteristics such as thermal dissipation capabilities are actually improved.

Except for a reduction in size, the semiconductor die in a MICROSEAL diode is identical with that found in an equivalent glass package.

To form the MICROSEAL structure, a diode assembly is enclosed within a ceramic cylinder and the unit then sealed with metal and caps. To provide polar discrimination, the diode cathode electrode is gold clad, the anode coloured silver. In addition, the cathode electrode or manual techniques may be used to orient the diodes before insertion into the circuit.

In the construction of Hughes International (U.K.) Ltd. MICROSEAL transistors, the transistor die is bonded directly to the bottom end plate, while two wire leads connect the emitter and base to two isolated portions of the top surface.

To facilitate the orientation of the transistor within a circuit, an egg-shaped design has been established with a 0·070 inch dimension in the longer direction. As in the case of the diode, the collector electrode is gold clad to provide visual identification and is also attracted to a magnet for automatic handling. Combined with the eccentric shape, this polar information removes any chance of error in placing the base, emitter, and collector contacts in the proper location in the circuit.

Circle **71** *for further details.*

Reflex Camera

A REFLEX camera, the Corfield 66, is being put on sale in the United Kingdom and abroad by K. G. Corfield Ltd., of Ballymoney, Co. Antrim.

The Corfield 66 is priced £75.

Any lens from 50 mm to 400 mm focal length can be fitted to the camera, which takes a 2¼ inch square picture on roll film, sheet film or plates.

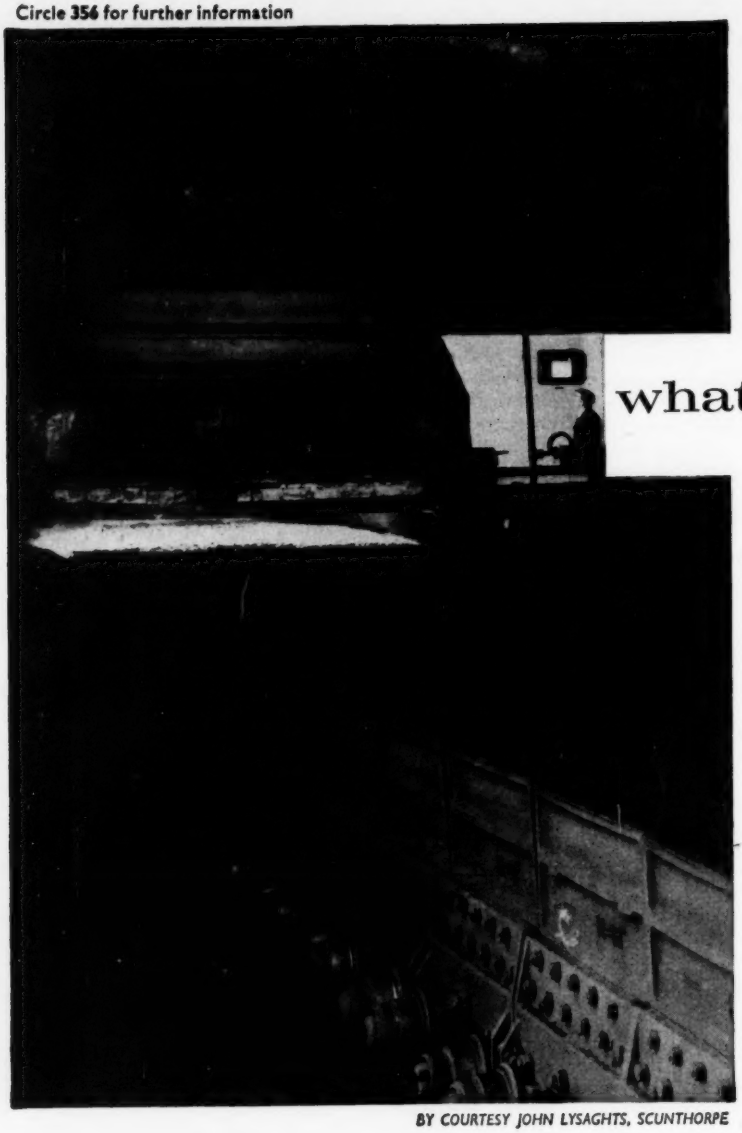
Circle **72** *for further details.*

Printed Circuit Jack Socket

A NEW printed circuit receptacle jack designed for miniaturisation and assembly cost saving is announced by Sealectro Corporation. The new SKT-111PC jack features a p.t.f.e. body and spin-over mounting which provides vertical mounting on the printed circuit board.

The new jack is only 0·381 in. overall in height before spin-over of mounting stud. It is designed to accept a standard 0·080 in. diameter probe × 0·250 in. length maximum. Overall diameter of the body is 0·218 in.

Circle 356 for further information



BY COURTESY JOHN LYSAGHTS, SCUNTHORPE

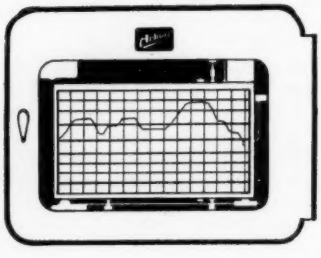
what is the gas flow?

If you need to maintain a continuous record of the gas or air flow an Arkon (Model 1601) Recorder will answer this and other problems.

What is the roof pressure on the open hearth furnace? What is the combustion-zone pressure in the soaking pit? For these critical measurements the recorder must be sensitive to changes as low as 1/1000″ W.G. Arkon pressure and vacuum recorders have overall ranges as low as 0.1″ W.G; they use a 6″ high continuous chart with a high degree of magnification.

A wide variety of ranges are available with these recorders (such as metric charts for coke oven applications). Other Arkon flow recorders measure blast furnace gas, producer gas, air; the other instruments are portable pressure and vacuum indicators and recorders, pressure and vacuum gauges, effluent flow recorders, specific gravity and level recorders and indicators, oil and water meters, and flow indicators. All Arkon; all robust; all sensitive.

More about these Arkon instruments in our latest literature.



WALKER CROSWELLER & COMPANY LTD · CHELTENHAM · GLOUCESTERSHIRE

Mounting is rigid and electrically sure as the printed circuit board is compressed between a metal shoulder and the spin-over.

Circle **73** *for further details.*

Subminiature High-speed Switching Diode

THE GEX71, a new germanium gold-bonded diode from G.E.C. Semiconductor Division, is now available in sample quantities. This diode is mounted in a subminiature, all-glass case and is characterised by a very fast transient response, making it particularly suitable for use in high-speed switching circuits.

Maximum continuous reverse voltage rating ...	10 V
Maximum continuous forward current rating ...	30 mA
Maximum peak (< 5 ms) forward current rating ...	100 mA
Typical forward voltage drop at 10 mA	0·45 V
Typical total recovered charge (10 mA forward current switched off with a reverse pulse of 5 V magnitude, with a rise time of less than 2 ns and at least 1 μs duration)	20 pC

Circle **74** *for further details.*

Direct Reading Anemometer

A CAPACITANCE sensing tachometer has been developed by Messrs. Grunther Industrial Developments Ltd. which has proved very reliable and it can be adapted to work direct from the vane assembly of a standard anemometer. It is available from Short & Mason Ltd.

The instrument can be used as a portable self-contained airmeter or as a fixed installation. The probe unit, which is attached to the head, consists of a few reliable electrical components encapsulated in epoxy resin, and is completely unaffected by extremes of temperature and vibration.

This unit generates an output pulse every time an anemometer blade passes in proximity to it, these pulses are fed to the indicator unit via the connecting cable. Transistor circuits in the indicator unit provide an output voltage proportional to the rate at which the pulses arrive, this in turn is applied to the meter and a recorder output jack.

As the number of pulses arriving at any given time are exactly proportional to the anemometer speed, the system comprises an accurate method of measuring air flow.

Due to the novel method of detecting the passing of the blades there is no obstruction of air flow, and no drag or inertia to be overcome. This allows the full accuracy of the anemometer to be maintained over its entire range, and permits air velocities down to about 30 ft/min to be measured and recorded.

The upper limit of the instrument is determined solely by the mechanical strength of the vane assembly, thus one head can cover from 30 ft/min to 3,000 ft/min with suitable range switching.

Accuracy of the overall instrument is unaffected by the length of cable connecting the head and the indicator unit, and distances between units of up to 1,000 yards are quite practical. In addition an output jack is provided which allows a 0/1 mA recorder to be connected, this permits simultaneous indication and recording to take place.

Provision is also made for the battery to be re-charged *in situ* simply by connecting the unit to the mains, and the condition of the battery may be checked on the indicator meter by means of a position on the range switch.

For certain applications more than one head can be connected to one indicating unit (and/or recorder) via a simple selector switch. Thus, automatic (or manual) sampling of any number of distant points can be achieved with great ease. In addition a simple alarm circuit can be provided to give a high or low alarm signal when the air flow exceeds or falls below any predetermined value. Also by connecting the recorder output terminals to a standard electro-pneumatic transducer (3-15 lb/in² output) a complete automatic control system can be built up. Thus this anemometer is suitable for uses ranging from simple rapid and accurate single measurements of air flow in ducts, shafts or flues to the analysis or automatic control of complete and complex air or gas systems.

Anemometer Head	
Dimensions:	4¼ × 2 in. tube (Probe unit extension 2 in. beneath band)
Temperature range:	−35 to +100°C
Weight:	Approximately 2 lb
Connecting means:	Twin screened cable, 0·25 in. o/d
Max. cable length:	1,000 yards
Indicator Unit	
Dimensions:	9 × 5 × 4¼ in.
Temperature range:	0 to +45°C
Weight:	Approximately 6 lb
Ranges:	0/200, 0/1,000 and 0/5,000 ft/min
Meter:	4 in. mirror scaled, knife edge pointer
Recorder output:	0/1 mA on each range. Load 50 to 500 ohm
Accuracy:	±2% of f.s.d. inclusive of battery and temperature variations ±1% of f.s.d. on recorder output
Linearity:	±0·2% on any range
Battery:	DEAC 10/225 DK rechargeable cell, 20 hours' continuous use between charges
Other facilities:	The range selector switch incorporates an OFF position and a check for battery voltage

Circle **75** *for further details.*

A.C. and D.C. Ratio Standards

A NEW range of a.c. and d.c. ratio standards capable of measuring a.c. ratios to within one part per million and d.c. ratios to within ten parts per million is now available from The Wayne Kerr Laboratories Ltd.

Known as the 1000 Series, the range consists of six models, numbered 1000 to 1005, single models within the range being designed for high frequency, low frequency or d.c. operation, or a combination of these. Model 1000, for example, is for high frequency (50 c/s to 10 kc/s) and low frequency (30 c/s to 1,000 c/s) operation whereas Model 1005 is for d.c. operation and frequencies of up to 400 c/s only.

Main features of the a.c. sections of these ratio standards are their ability to measure ratios to 1·11111 with switching transient suppression, 6-place resolution and terminal linearity of 0·0001%. The d.c. sections of the 1000 Series use a Kelvin-Varley type resistive divider with six place resolution and a terminal linearity of 0·001%.

Typical applications for these new ratio standards are in calibration laboratories and for instrument standards or for any use where maximum ratio accuracy is required.

All units are equipped with robust, heavy-duty instrument switches and can be supplied in a case or ready for rack mounting.

Circle **76** *for further details.*

Plug-in Rechargeable Cell

THE "Etromat", rechargeable torch battery is now being manufactured by Electronics and Automation (London) Ltd. The rechargeable battery, the size of two U-2 standard cells, is charged by removing a cap, which simultaneously switches in the internal rectifier and also completely isolates the battery electrically, and then plugging the two 5-ampere standard British pins revealed directly into the mains plug-holes.

It is encased in a robust plastic and may be left for months in a torch-case. There is no corrosion, because the storage section is hermetically sealed and contains no chemicals to corrode the metal contact base.

The battery is constructed for recharging from 110 V to 250 V supplies. The life of one recharge is the same as that of the replaceable battery, which is usually three or four evenings of use. The charging time at 250 V is 14 hours and 20 hours at 110 V.

The voltage can be from 2·5 V to 6·0 V and the battery is always the size of two U-2 cells.

The light duty type is for operating with ordinary, standard torch bulbs of 0·15 ampere consumption. The heavy duty is for high amperage bulbs such as those required for industrial inspection, night watchmen, the police, ambulance drivers, motorists, seamen and so forth.

The voltage range for both types is: 2·5 V, 3·5 V, 5 V, and 6 V.

Retail Prices:

Voltage:	2·5 V	3·5 V	5 V	6 V
Light Duty:	29s. 6d.	35s. 6d.	41s. 6d.	51s. 6d.
Heavy Duty:	32s. 6d.	40s. 0d.	47s. 6d.	59s. 6d.

Circle **77** *for further details.*

Sub-miniature Solenoid Valves

A NEW basic design in sub-miniature solenoid valves has just been announced by the Skinner Electric Valve Division of Skinner Precision Industries, Inc. The new valves, described as the B Series, are particularly designed for use in hydraulic and pneumatic devices and control systems, and operate with all common media including many semi-corrosive fluids. Body and operating parts are stainless steel. According to the manufacturer, they are smaller than any other standard line of valves presently available, measuring 1 in. diameter × 2¼ in. high, and weighing 5 ounces. Orifices are $\frac{3}{64}$ in. and fluid connections are all $\frac{1}{16}$ in. p.t.f.e. Because of this small size, Skinner provides with each valve, fittings to adapt to standard ⅛ in. flared tube.

Operating differential pressures run from a vacuum of 5 microns to pressures of 150 lb/in². Three-way normally closed valves are now available from stock. Three-way normally open, directional control and two-way normally open and normally closed valves will be available shortly. Coils in most a.c. and d.c. voltages and frequencies are standard. Housings are available with choice of grommet or ¼ in. N.P.T. conduit for electrical connections.

Complete specifications, dimensions, flow characteristics, and other data and prices are available from British Arca Regulators Ltd.

Circle **78** *for further details.*

Forged Self-locking Nuts

SIMMONDS AEROCESSORIES LTD. are introducing the first precision forged self-locking nuts to be made available in this country.

Now in volume manufacture and available through the normal supply channels, the immediate range covers the internationally known Nyloc self-locking nuts in all the sizes, in both full and thin thicknesses, from ¼ in. to ½ in. diameter in unified fine thread.

Circle **79** *for further details.*

Sequence Timer

THE Rodene Electrical Co.'s range of sequence timers has just been extended by the addition of the "Magnacam", which can operate directly both switches and air valves.

The Magnacam has an epicyclic gear arrangement and the actuator of this clutch controls a further switch which can be used to lock in the timer.

The valves and switches are individually replaceable and inter-changeable. The valves are three-way units with ⅛ in. bore suitable for use at up to 80 lb/in². The switches are s.p.d.t. units rated at up to 15 amp, and are complete with their own substantial screw terminals.

Each switch or valve is operated by two cams, one setting the "on" and the other the "off" points. A drum calibrated in degrees is attached to each cam and a further one gives the camshaft position. The cams are the special Rodene "quick-set" type which can be set quickly, precisely and permanently. They are 50% greater in circumference than those on other Rodene timers allowing more accurate, settling and reducing the minimum "on" time to that resulting from 4° of rotation, or, if two switches are used in series, to 1°.

Up to 24 pairs of cams can be fitted and camshaft speeds range from one revolution in (7 seconds) × (number of cams) to about one revolution per week. The camshaft action can be forward drive with automatic reset; forward drive only; or if two "Rodene" self-clutching motors are fitted, forward and backward drive.

The distributors for the Magnacam are D. Robinson & Co. Ltd.

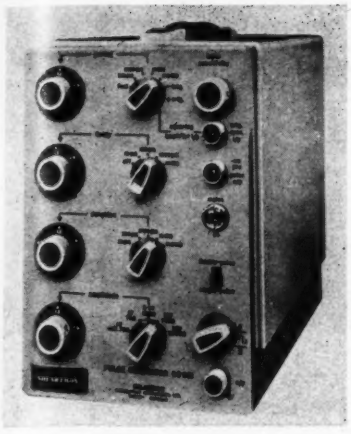
Circle **80** *for further details.*

On-Off Valve

GENERAL CONTROLS LTD. are now manufacturing in this country an adjustable slow opening gas valve B.55 for various burner and installation requirements. It features a 3-way pilot operator. There is no continuous bleed gas.

Type:	electric diaphragm, normally closed, 2 wire
Pressure:	5 lb/in² max. 2½ in. w.g. min.
Opening time:	adjustable to 60 seconds
Closing time:	5 sec. or less.

Circle **81** *for further details.*



Pulse generator

Pulse Generator GO 1101

THE GO 1101 pulse generator addition to the range of Solartron test equipment has a pulse repetition rate continuously variable from 10 c/s to 500 kc/s (2 μsec—100 msec period), and can be controlled by internally or externally derived trigger pulses. The pulse amplitude is adjustable over the range 0·5 V to 100 V, positive or negative-going, with switched selection of single or double-pulse output. The duration of the main pulse can be set to any time between 1 μsec and 100 msec, and the incidence of the main pulse delayed on the pre-pulse by any period between 1 μsec and 10 msec. The negative-going edge of a 3 V amplitude main pulse has a rise-time of less than 12 nanosec. An external synchronisation facility enables the GO 1101 to be employed as an oscilloscope sweep-delay generator or frequency divider. The instrument will operate from 100–125/200–250 V, 50–60 c/s, a.c. mains input, and has a power consumption of 100 watts. It is of compact construction, measuring $11\frac{3}{8} \times 7\frac{5}{16} \times 15$ in. deep. The weight is 15 lb.

Circle **82** *for further details.*

Inspecting Sides of Small Holes

IT is often required to view the side walls of small holes in engineering components both in the case of new parts in production factories and used items in maintenance and repair shops.

P. W. Allen & Co. have introduced a range of bore viewers, covering holes from $\frac{3}{16}$ in. to approximately $1\frac{1}{4}$ in. in diameter and in length up to 8 in.

These are simple and robust tools for workshop use not requiring delicate focusing.

The complete bore viewer is in three parts:

(a) battery handle
(b) light probe
(c) sleeve with elliptical mirror.

They are made in two sizes with three lengths available in each size.

Series 316. For holes $\frac{3}{16}$ in. to $\frac{9}{16}$ in. diameter
With a mirror $\frac{11}{64}$ in. wide on a 0·08 in. diameter probe

Series 380. For holes $\frac{7}{16}$ in. to $1\frac{1}{4}$ in. diameter
With a mirror $\frac{3}{8}$ in. wide on a 0·109 in. diameter probe.

The side walls of the bore are illuminated by the small lamp and viewed in the mirror through the magnifying lens. For the 2 in. viewers the magnification is 4× and for the 6 in. and 8 in. viewers 2×.

The light probe without the sleeve is used to view the bottom of blind holes, valve seatings, etc.

Provision is made for fitting a suitable washer (fibre, cork, etc.) to the end of the sleeve to centralise the viewer in the bore under inspection.

The viewers are made throughout in brass, finished in bright nickel plate.

Circle **83** *for further details.*

R.C.L. Standards

Resistance Standards

RESISTANCE standards Types NM1 and NM2 are hand wound with windings giving very low residuals and are carefully aged and controlled, so that they may be relied upon for maintaining their rated values over long periods of time.

The standard values are 1, 10, 100, 1,000, 10,000 absolute ohms. Any value between 1 ohm and 50,000 ohms can be supplied to order. Accuracies are ±0·05% or 1 milli-ohm, whichever is the greater. The time constant is 10^{-7} to 10^{-9} seconds, and the temperature coefficient is about 0·002%/°C for temperatures between 15 and 35°C. The thermal e.m.f. is μV/°C.

The dissipation is 1 watt. The standards are supplied in either a single value (Type NM1) or with two values (Type NM2) mounted in a walnut cabinet with black insulating panel.

Dimensions are $2\frac{1}{2} \times 4\frac{1}{4} \times 4\frac{1}{4}$ in.

Capacitance Standards

Capacitance standards Types KN1 and KN2 are laboratory standards with two capacitance values in the same box. Maximum voltage—200 peak and mounting is in a walnut cabinet with black insulating panel. The dimensions are $2\frac{1}{2} \times 4\frac{1}{4} \times 4\frac{1}{4}$ in.

Inductance Standards

Inductance standards Type SN1 and SN2 inductances are air-core coils on wooden forms which have been boiled in paraffin wax before and after winding. They are tapped at 1/100 of their total value. The metal parts in the field of the coil are reduced to the lowest possible amount. Mounting is in a walnut cabinet with black insulating panel and dimensions are $2\frac{1}{2} \times 4\frac{1}{4} \times 4\frac{1}{4}$ in.

These instruments are by Danbridge, of Copenhagen, and are being marketed in this country by Metrix Instruments Ltd.

Circle **84** *for further details.*

Thermostat

THE T80 room thermostat now being manufactured by General Controls in this country is suitable for use in millivolt self-generating control systems only. It has an operating differential of $\frac{1}{2}$°F. The operating mechanism consists of a U-shaped bi-metal with thermo-poised contacts. The temperature range covered is from 50 to 90°F.

Circle **85** *for further details.*

Ferrite-cored Decade Inductors

DECADE inductors Types D13 and D14 are useful for laboratory tests and measurements on wave filters, tuned circuits, etc. The inductors used are wound on ferrite cores providing a high Q value even at the lower audio-frequencies. Their accuracy and stability allow their use as secondary standards of inductance.

The range is from 10 mH to 1 H and they may be supplied as assemblies of 3 or 4 decade units.

The coils have the values 1-2-2-5 units and are series connected. The decade switch short-circuits the appropriate coils to give the values required. Temperature coefficient is about $+100 \times 10^{-6}$ °C.

These inductors are manufactured by Danbridge, of Copenhagen, and are available in this country through Metrix Instruments Ltd.

Circle **86** *for further details.*

Refractosyn Angle Sensor

ORDINARY 60 c/s power provides a rectified current to a tungsten lamp, creating a modulated light component. This light is directed to a collimating lens which causes parallel rays to strike the target mirror and reflect back to the sensor prism.

The angle between the hypotenuse face of the prism and each of the other two faces is about 42 degrees, the critical angle for the prism material. This angle causes virtually all of the normally incident light to strike the prism sides at the critical angle and hence be totally internally reflected.

When the mirror deviates slightly from null, considerable light will refract through one or the other of the prism faces and strike the corresponding photocell. The resulting unbalance in photocell signals creates a 60 c/s output signal.

After amplification the signal is demodulated to produce a d.c. signal proportional to the mirror deflection from null.

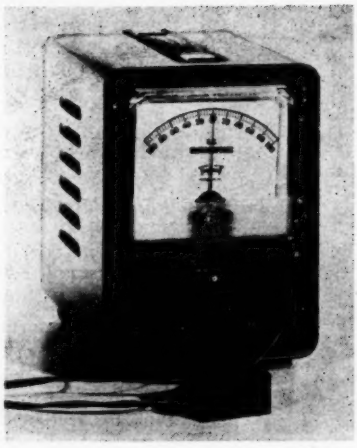
Two flat glass plates, placed between the lamp and the lens, provide a coarse and fine adjustment for initial zeroing of the Refractosyn. As the plate is rotated, the virtual image of the lamp as seen by the lens moves very slightly, causing a change in the direction of the light beam.

Initial zeroing is accomplished by rotating the plate(s) until the electrical output is nulled. Calibration of the gain of the Refractosyn may be accomplished by relating a fixed rotation of the glass plate to the full scale electrical output. An amplifier gain-adjustment is provided for this purpose.

The prism sensor was originally developed for the navigation of space vehicles and it provides high sensitivity without resorting to long optical paths and cumbersome and expensive arrays of lenses and mirrors.

The rectified lamp provides drift-free modulated signals without the use of light-chopping motors which soon wear out under continuous operation. The lamp is operated at well under rated voltage to provide years of maintenance-free life.

The Refractosyn is easily adapted to existing instruments by affixing a half-inch square mirror to the moving member.



Refractosyn angle sensor

Sensitivity:	Less than one second of arc at nominal voltage
Null drift:	Less than arc sec/week at nominal voltage
Electrical output:	Transistor amplifier generates meter output to ±100% full scale. Sensitivity adjustable from 0 to more than 10% full scale per second of arc at nominal supply voltage. Auxiliary output jack is available for oscilloscope or recorder output. 60 cycle modulated light limits bandwidth to 20-30 cycles
Operating life:	In excess of two years of total operating time. More life and less sensitivity may be attained by decreasing the supply voltage. More sensitivity and less life will result from increasing the supply voltage
Power requirements:	2 watts, 115 volts, 50/60 c/s, no special regulation required
Mirror distance:	2 to 3 in. from Refractosyn. Greater distances possible with sensitivity varying inversely with distance
Ambient lighting:	An unusually high amount of ambient light may be tolerated, particularly daylight. Modulated fluorescent or tungsten lamps may prove troublesome at the highest gain setting, but moderate shielding will easily circumvent this.

Circle **87** *for further details.*

Coaxial Switch Units

Two coaxial switch units measuring 2½ in. diameter and providing 3 to 30 discrete circuits are now available from The Wayne Kerr Laboratories Ltd.

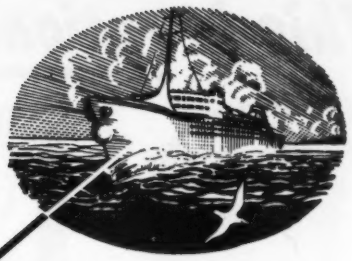
These sub-miniature switches, designated CSU-1 and CSU-1A, are designed for the remote electrical control of decade or binary information. Within each unit are three or four switches with up to twelve positions, all of which are controlled by the concentric dial arrangement.

Both units have bold, in-line readout and rugged gear-driven switch assemblies and both are available for servo ring or flange mounting. Connections to these switches are made by a sub-miniature connector at the rear.

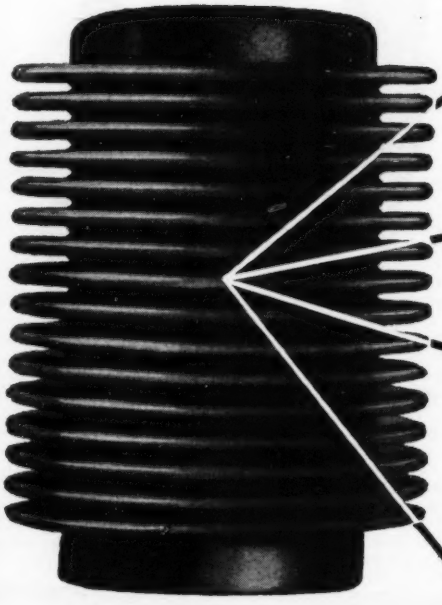
Model CSU-1 is certified to meet all applicable military specifications and will operate under severe environmental conditions.

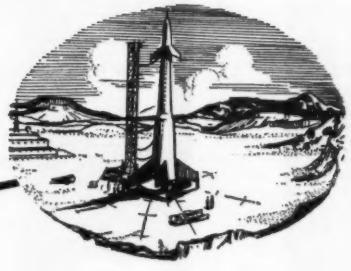
Circle **88** *for further details.*

Circle 357 for further information

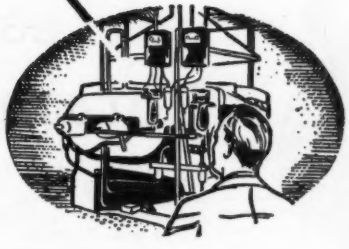


from ships to satellites...





...cookers to controllers



...HYDROFLEX SEAMLESS METAL BELLOWS HAVE UNLIMITED APPLICATION —in pressure sensitive systems, thermostatic systems, flexible shaft couplings, pressure seals and vacuum seals.

whatever you manufacture there's an application for

HYDROFLEX

seamless metal bellows

HYDROFLEX

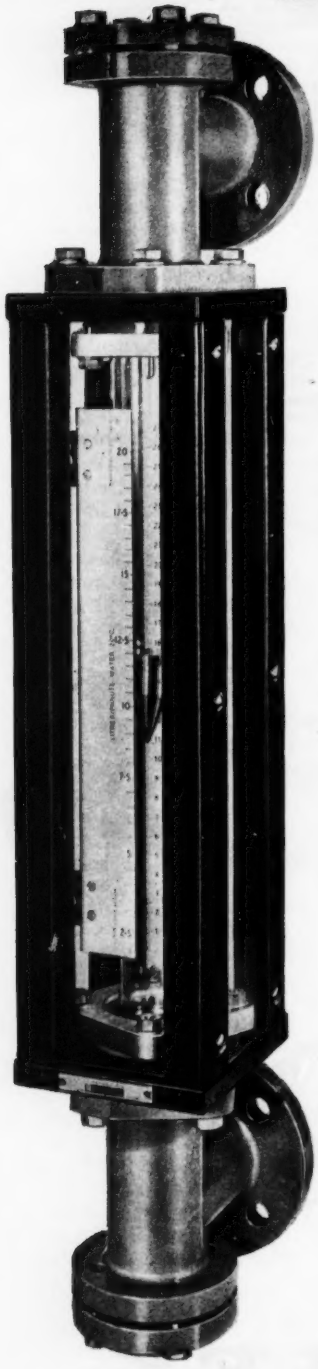
Write for details to Dept. IP

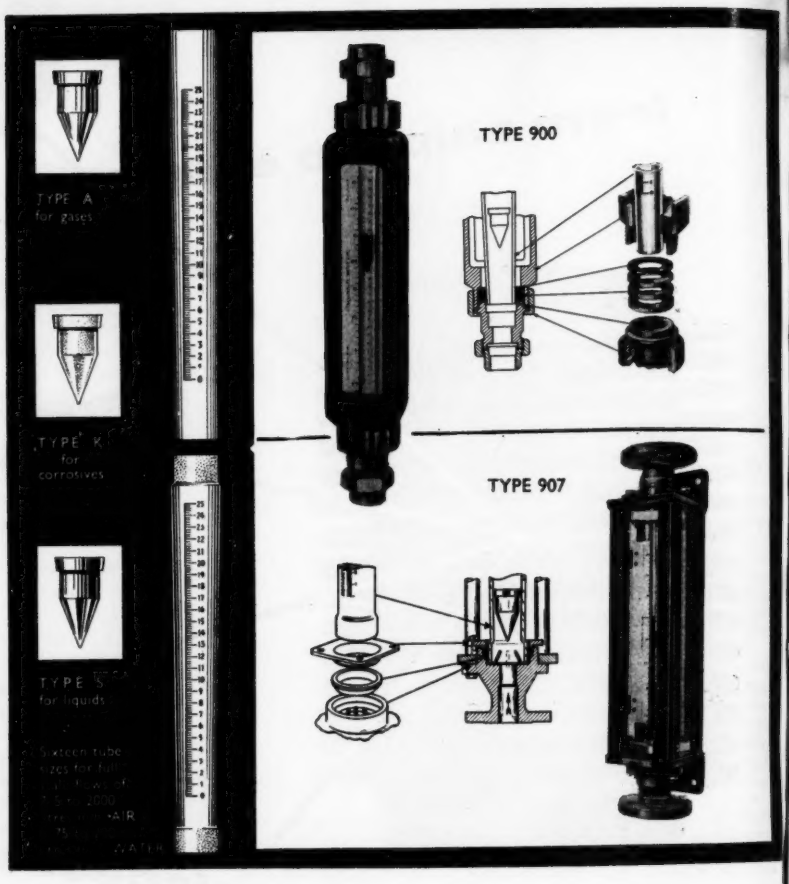
B.29

DRAYTON CONTROLS LTD. (BELLOWS DIVISION), Bridge Works, West Drayton, Middx. *West Drayton 4012*

Circle 358 for further information

This is rationalised flow measurement





the 'Metric' series Rotameter

The 'Metric' series of flowmeters is available from stock. Interchangeable and alternative metering elements provide a new flexibility in liquid and gas rate-of-flow measurement.

In Principle

Five sizes of mounting accommodate the sixteen sides of glass metering tube and all have rationalised installation dimensions. Floats of stainless steel, light alloy, or korannite (a ceramic material) and all components are interchangeable for a given size.

In Practice

Interchangeable floats of different composition facilitate the conversion of an instrument to meter fluids of different natures; flow scales can also easily be changed as appropriate. These flow scales refer directly to the millimetre scale fused on to the glass tube; they can be provided by the manufacturer or produced by the user from calibration charts.

The type 900 Frame is for low pressure non-corrosive service.

The types 907 and 914 Frames are for rough industrial service and use the Metric 'B' tubes with ground ends and interchangeable gland packing including P.T.F.E. The chassis is a welded structure, nylon covered, and connections are normally of cast iron, stainless steel or rigid P.V.C. Many accessories including a photo-electric alarm can be fitted to these instruments.

Magnetic coupled indicating or transmitting flowmeters using 'Metric' elements are available in certain sizes. All metric meters and spare parts are available from stock.

Write for full technical details, quoting reference I.P./2020/41

ROTAMETER
FLUID MEASUREMENT AND CONTROL
FLOW-DENSITY-LEVEL

ROTAMETER MANUFACTURING CO. LTD., PURLEY WAY, CROYDON, SURREY Telex: 24292 Telephone: CROydon 381
M41/414

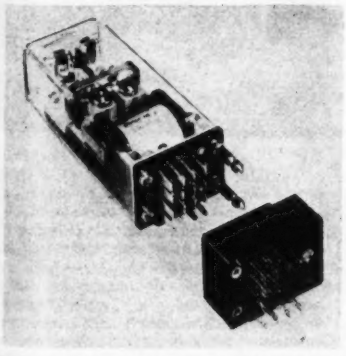
NEWS OF THE INDUSTRY

INSTRUMENTS

THE UNIVERSITY OF LONDON has placed an order with Ferranti Ltd. for the new **Atlas computer.** This brings the number of Atlas computer installations to three, the first being commissioned by the University of Manchester, and the second by the National Institute for Research in Nuclear Science.

The British Petroleum Co. is providing approximately a quarter of the cost and will, in return, use it for the full-scale integration of their refinery and supply programme over a period of five years. The University's Computer Unit will be responsible for the machine, which will be operational towards the end of 1963, providing computing facilities for all colleges of the University and for many outside organisations. The work to be performed by the computer will cover a wider range in the fields of science and engineering than is, at present, possible with the Mercury computer, and will also deal with extensive calculations on mechanical structures, complex non-linear problems, the analysis of artificial satellite records, linguistic analysis and mechanical translation.

B. & R. RELAYS are now making available over here a range of **Siemens polarised relays,** of which there are seven basic relays all of the Carpenter type. The range covers both side and centre stable versions and the type numbers are from 63-69.



Siemens' polarised relays housed in plastic covers. They are available with plug-in base and socket as shown, or with solder tag bases if required

GOODMAN INDUSTRIES LTD. have withdrawn from their range of **vibration generators** the VG108 Mk. II (5,300 lb peak thrust). It is shortly to be replaced by a new vibration generator now under development.

OVER 2,000 yards of **mineral insulated cable** has been supplied by British Insulated Callender's Cables Ltd. to provide Gedling Colliery with pit surface modernisation.

COMPANIES

THE American firm of Consolidated Electrodynamics Corporation Inc. have formed **Consolidated Electrodynamics Corporation (U.K.) Ltd.**

C.E.C. (U.K.) Ltd. is a wholly-owned subsidiary of Bell & Howell, S.A., Fribourg, Switzerland, which in turn is owned by the Bell & Howell Co., Chicago. C.E.C. Inc., Pasadena, is wholly-owned by the Bell & Howell Co. and, itself, owns the Consolidated Electrodynamics Corporation, G.m.b.H., at Frankfurt, Germany.

The merchandising of both the new electronic instruments of C.E.C. Inc. will be the initial activity of the new British company. They include data processing equipment, recording oscillographs, high precision galvanometers, instrumentation magnetic tape recorders for analogue, f.m., and pulse duration modulation recording and ancillary electronic equipment such as stabilised power and excitation units, data and carrier amplifiers, bridge balance units and various types of pressure transducers, accelerometers and vibrometers and precision electrical connectors.

Plans have already been formulated for an immediate manufacturing programme to produce ranges of C.E.C. transducers and oscillographs specially designed to meet British and European requirements. When the works is in operation in the middle of 1962, the products, which will be offered at competitive prices, will be for world-wide export.

With the establishment of this company it will now be possible to obtain the whole of the range of C.E.C. products both at home and overseas.

THE new laboratory for the testing and development of aircraft generation systems by the **Plessey Co. Ltd.** is now operational and is situated at Eastern Avenue West, Romford, Essex.

The initial installation, currently proving a four generator system of 160 kVA total for the Vickers VC 10, is capable of handling four paralleled channels of equipment up to 120 kVA normal load per channel with complete simulation of environmental conditions likely to be met by aircraft of the next decade. Future projects include systems testing for the BAC III and for military aircraft. The generator drives have a speed range in excess of 3·1 with controlled acceleration up to 1,200 rev/min per second and a capacity of 200 hp per drive. Three-phase loading, both resistive and reactive, is variable between zero and 150 kVA per channel. The comprehensive cooling facilities installed enable direct simulation of supersonic flight conditions.

They have also installed an advanced system of automatic testing for generation electronic equipment. The work is carried out by point-to-point fault location consoles, which can be programmed by punched tape for automatic continuity and wiring verification on any type of control or ancillary unit.

SIGMA, Science in General Management Ltd., is a new organisation of scientists which has been formed to advise senior administration on problems of management strategy by the application of scientific methods and the techniques of scientific research. The organisation, led by Stafford Beer and Roger Eddison, is jointly operated by Martech Consultants Ltd., of London, and Société d'Economie et de Mathématiques Appliquées, of Paris. The head office of SIGMA is situated at 69 Grosvenor Street, London, W.1.

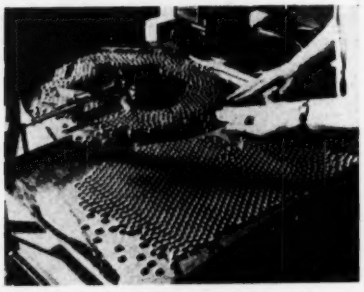
A NEW organisation, **Technical-Commercial Surveys,** has been established by Dr. C. A. Redfarn, consulting chemist, and Aubrey Wilson, an industrial marketing research consultant at 1 Dover Street, London, W.1, which will offer, apart from technical surveys and consultancy, research into industrial markets at home and overseas, product diversification studies, application studies and product and price intelligence services.

Electron Microscopy, the first scientific film made by the **AEI Film Unit,** was one of the only two British films to gain a Certificate of Merit at the 15th Congress of the International Scientific Film Association held in Rabat, Morocco, in September. Earlier this year the film received four awards at the International Industrial Film Festival in Turin.

A **Special Computer Division** has been formed within the data processing group of divisions of Elliott Brothers (London) Ltd. to specialise in tackling the problems associated with the on-line application of digital computers to continuous operations. The Division is at present engaged upon the development of an experimental air traffic control system, an advanced airline seat reservation system and the

control and switching of telegraph communications networks.

A **Programming Systems Division** which will concentrate solely on the design and development of automatic programming systems has been established by the American associates of Honeywell Controls Ltd. who formed an electronic data processing division in Britain earlier this year. The company has invested large sums in the creation of these automatic programming aids. The aids for the Honeywell 800 computer include: FACT; algebraic compiler; COBOL; ARGUS; card ARGUS assembly system; programme test system; IBM and Univac simulators; library addition and maintenance system; programme selection processor; and an extensive library of scientific routines.



Quality control testing Mallory batteries at a rate of 85 *per minute*

Mallory Batteries Ltd. have recently moved to a new and larger factory at Crawley covering 55,000 sq. ft. Prior to the advent of transistorised instruments, Mallory mercury dry cell batteries have mainly been used industrially and the consumer field till then had hardly been touched.

With approximately 30% of its entire production being exported to the Continent, the company plans to step up European exports and will be adequately catered for by the increased production area.

THE opening of a new office building by **R. B. Pullin & Co. Ltd.** took place recently.

The completion of the office block marks the second stage of reconstruction at Phoenix Works. Some five years ago a new building housing the development laboratories and assembly departments was completed at the rear of the factory site.

A NEW division of **Eversheds & Vignoles Ltd.** has been established at Devonshire Works, Dukes Avenue, Chiswick, to meet the increasing volume of orders and permit further expansion of their fractional horse power motor business.

RACAL ENGINEERING have changed their name to **Racal Electronics Ltd.** as a result of their expanding activities. Racal Engineering was founded in 1951 and has become acknowledged by users of communication equipment all over the world.

THE copying, microfilm and visual products section of the Minnesota Mining and Manufacturing Co. Ltd. have formed a division known as the **Thermo-Fax Business Equipment Co.** to handle the sales of the Thermo-Fax and Filmsort equipment, and the introduction of new products.

CONTRACTS

International Computers and Tabulators Ltd.'s first order for the new National Data Processing Corporation's electronic document processing system has been placed by the National Provincial Bank.

The bank is to rent equipment with a capital value of approximately £85,000 for initial use in sorting cheques to branch order and automatically listing the amounts encoded in magnetic ink. Experiments in cheque-sorting techniques are also envisaged by the bank staff.

The equipment, which is to be installed in the bank's London clearing department in November, 1962, will consist of a document processor and audit lister. Document encoders for printing magnetic ink characters on cheques will also be required.

The principal machine in the system is the document processor—basically a paper document sorter with 18 pockets—which reads and sorts cheques at a constant speed of 1,200 documents a minute. The tolerance of the processor's vacuum feed admits intermixing of card and paper documents of varying weights and sizes. Check digits on account numbers, etc., may also be proved without interrupting processing. The control panel of the processor permits a considerable amount of selective or programme sorting.

The National Data Processing Corporation of Dallas, Texas, are makers of document handling equipment designed for bank automation. I.C.T. concluded a long-term marketing and manufacturing agreement with them in May of this year.

The Plessey Co. Ltd. has received a contract to install a remote control and telemetering installation for the Norwich Division of the Eastern Gas Board, commencing in February, 1962. The system, which has its control centre at Norwich, will cover eight gasholder sites in the division and will be capable of extension to a further six out-stations in the division. The installation will display at the Norwich control room the following functions from each of the out-stations: gasholder stock, medium pressure and district pressure, all with high and low alarm indicators. Remote control is provided for booster on/off, volumetric governor and anti-freeze on/off. Information is transmitted in the form of digital code signals over G.P.O. line and has been officially approved for line transmission as well as being suitable for use with radio link or power line carrier installations.

Honeywell Controls Ltd. have received orders from Richard Thomas & Baldwins for process control instrumentation valued at £¼m. to be installed at their new integrated Spencer steelworks.

Temperature, flow, pressure and oxygen analysing equipment will be supplied for reheating and heat treatment furnaces being installed by Priest Furnaces Ltd., Stein & Atkinson Ltd. and Incandescent Heat Co. Ltd. although much of the installation of the other equipment to be supplied will be done by Honeywell.

The Westrex Co. Ltd. are supplying a multi-purpose recording channel to Location Sound Facilities Ltd. The channel has been specially designed to provide for direct and transfer recording work in direct recording of 3 track stereo on 35 mm film, post synchronisation of single tracks on 35 mm and 17·5 mm film, director recording of single tracks on 17·5 mm film at half normal speed and transfer recording at half and double normal speed.

The Westrex Co. Ltd. are also to supply a new all-metal re-recording console to World Wide Pictures Ltd. for their new sound recording studios. This console incorporates rapid post-synchronisation controls, a set of effects equalisers, signal equipment and facilities for the injection of artificial reverberation into any one of the incoming sources of sound.

Brush Electrical Engineering Co. have received a contract from the G.P.O. to supply control equipment, motors, generators, and servo equipment for a steerable aerial now under construction at the Goonhilly Downs Post Office Radio Station in Cornwall. Another Hawker Siddeley company concerned in the project is Whitworth Gloster Aircraft, whose Electronics Division is building some of the digital electronic equipment. Consulting Engineers to the G.P.O. are Husband & Co., of Sheffield.

The success of the xperiment requires very accurate steering of the aerial. The electronic control system must, therefore, work to very fine limits of accuracy and requires the generation of highly accurate positional information by optical shaft encoders. This will be compared with predetermined steering information provided by a programmed tape and corrective

Mr. D. W. Hooper, chief organising accountant of the National Coal Board, visited Chelmsford recently to discuss data transmission equipment with members of Marconi's Communications Division.

*He is seen (centre) with Mr. A. R. Laws (left), sales manager of Marconi's Communications Division, and Mr. B. Mayson, assistant chief of sales group, examining units of the Marconi HU*131 *data transmission equipment. It is the only data transmission equipment to be developed in this country for the transmission of punched card information with error correction by automatic repetition.*

signals, converted from digital to analogue form, will be supplied to the servo mechanisms. The signals resulting from this process will be fed to the motor control system, which will then cause the aerial to move to the desired position.

George Kent Ltd. has received an order for instrumentation worth more than £32,000 for Trawsfynydd Nuclear Power Station, which is due to be commissioned in 1963.

Over forty Mark 3 electronic strip chart instruments are to be used in connection with the recording of fuel element, graphite and reactor gas temperatures, reactor gas pressures and flow, water in CO_2, reactor power levels and burst can detection.

In the tubine hall a further twelve Mark 3 electronic recorders are to be used for temperature, temperature difference and pressure recording.

Twenty-seven Kent detecting elements for use in the measurement of water flow are included in the order.

The Plessey Co. Ltd. has received a contract valued at approximately £450,000 for further ferrite core memory systems, complete with their own special stabilised power supplies for the Ferranti Atlas computer. This order for Atlas, which is the second to be received, is to be used by the U.K.A.E.A. for highly involved calculation work in the field of nuclear physics, and the value of the total installation will be of the order of £3½m. The Plessey memory system will account for some £350,000 of this.

HOFFMANN MANUFACTURING CO. LTD. have placed an order with **Wild-Barfield Electric Furnaces Ltd.** for a continuous furnace capable of treating work at the rate of 80 lb/h. Switchgear, automatic temperature control instrumentation and atmosphere equipment will complete the installation.

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY has placed an order for an **IBM "Stretch" computer** to be installed in 1962.

THE new London Western District Office of the G.P.O. has awarded **Sovex Ltd.** a six-figure contract for a letter conveyor system.

THE FORD MOTOR COMPANY LTD. is to order another **LEO computer.** Fords are already using two LEO computers, one at the Aveley spare parts depot, and the other at the Dagenham plant. The new machine will be installed at Aveley.

ESSO PETROLEUM (IRELAND) LTD. have placed an order with **International Computers and Tabulators Ltd.** for their new Type 1301 electronic computer. The machine, which has a capital value of £70,000 will be installed in 1963.

The computer is to be employed for sales accounting, payroll production and for general accounting, including control of fixed assets and stocks, the preparation of statistics, pension fund accounting, and investment analyses.

AGREEMENTS

AN Anglo-American production and marketing agreement has been concluded between **Dowty Hydraulic Units Ltd., Rubery Owen and Co. Ltd.** and the **Hydraulic Units Specialties Co.,** of Wisconsin, U.S.A. Under the agreement, the full range of Husco hydraulic control valves, at present manufactured in America by the Hydraulic Units Specialties Co., will be produced in this country by Rubery Owen & Co. They will be marketed in Britain and throughout Europe by Dowty Hydraulic Units Ltd. as the Dowty-Husco range.

THE **Plessey Co. Ltd.** has granted an exclusive licence to the **Centralab Division of Globe Union Inc.,** of U.S.A., to manufacture, sell and use in the U.S.A. moulded track potentiometers made to Plessey designs.

The Centralab Corporation has also been granted a non-exclusive licence which applies to Canada and Central and South America. The initial period of the agreement is 10 years.

Stages in the production of Plessey moulded track potentiometers: in the centre, moulding powder for the track being compressed to the required shape; on the left, compressed powder being heat cured to form the finished track.

AN agreement has been reached between **Elcontrol Ltd.** and **The Siegler Corporation, Magnetic Amplifiers Division,** of New York, for the exclusive sale and manufacture of Elcontrol's products in the United States and Canada.

International Computers and Tabulators Ltd. have reached an agreement with the **Radio Corporation of America** for the non-exclusive exchange of technical information and patents in the field of data processing.

EXPORT

THE engineering director, Mr. R. S. Medlock, A.R.I.C., A.M.I.E.E., A.M.I.Mech.E., and mechanical meter marketing executive, Mr. R. V. May of **George Kent Ltd.,** recently left this country en route for South Africa and South America, their objective being to maintain closer personal liaison between the parent company and overseas representation.

Mr. Medlock devoted the majority of his four-week stay to discussions with Kent personnel at the Johannesburg subsidiary company and at the Salisbury, Southern Rhodesia, branch office, as well as visiting existing and potential customers within these areas. He also addressed an assembly of the Instrument and Control Society of South Africa. Mr. May travelled via the West Indies to the Kent Colombian associate company, Medidores Kent Colombiana at Bogota. Following the interest shown in the latest series of SM and JSM domestic water meters, Mr. May intends to return to the Caribbean area to obtain evaluation of this expanding market, after consultations with company agents.

SIR WILLIAM MCFADZEAN, chairman of the **Export Council for Europe,** addressing the Golden Jubilee Export Conference of the British Electrical and Allied Manufacturers' Association in London last month, announced that there had been an increase during the first eight months of this year of more than 14 per cent in Britain's exports to Europe, compared with the same period last year.

He emphasised that the following factors should be taken into consideration if Britain was to maintain this increase: encouragement to top executives to undertake visits abroad to assess the opportunities at first hand; visits to trade fairs where potential competitors can be evaluated; publicising our achievements; and trade in Europe.

Sir William then said that many firms were doing a first-class job already, but there were still too many stories of broken delivery promises and lack of service for this aspect of the situation to be shrugged off.

He said that the successful conclusion of the present negotiations for Britain to join the Common Market would make a dramatic change in our prospects of increasing our trade with Western Europe as a whole.

The Telegraph Construction and Maintenance Co. Ltd. have exported a new type of electro-hydraulic deep-sea oceanographic winch, designed to the requirements of the Department of Mines and Technical Surveys of Canada, for installation in one of their vessels.

The barrel of the winch accommodates 30,000 ft of $\frac{3}{16}$ in. wire, the latter having to work very near its yield point. For this reason, a tensioning control device is incorporated to over-ride the effect of varying amounts of wire on the drum.

A WHOLLY-OWNED subsidiary has been formed in Aachen, West Germany, by **Electronic Associates,** to handle sales of its instrument line in that country.

Electronic Associates Inc. GmbH will act in support of the present sales organisation based in Brussels, for Western Continental Europe. Included in the range of products to be handled by the subsidiary are the TR-10 transistorised desk-top size general-purpose analogue computer; small plotting boards and other instruments used in analogue computing processes.

Racal Electronics have formed a new company, Racal (Australia) Pty. Ltd., to be responsible for marketing Racal and

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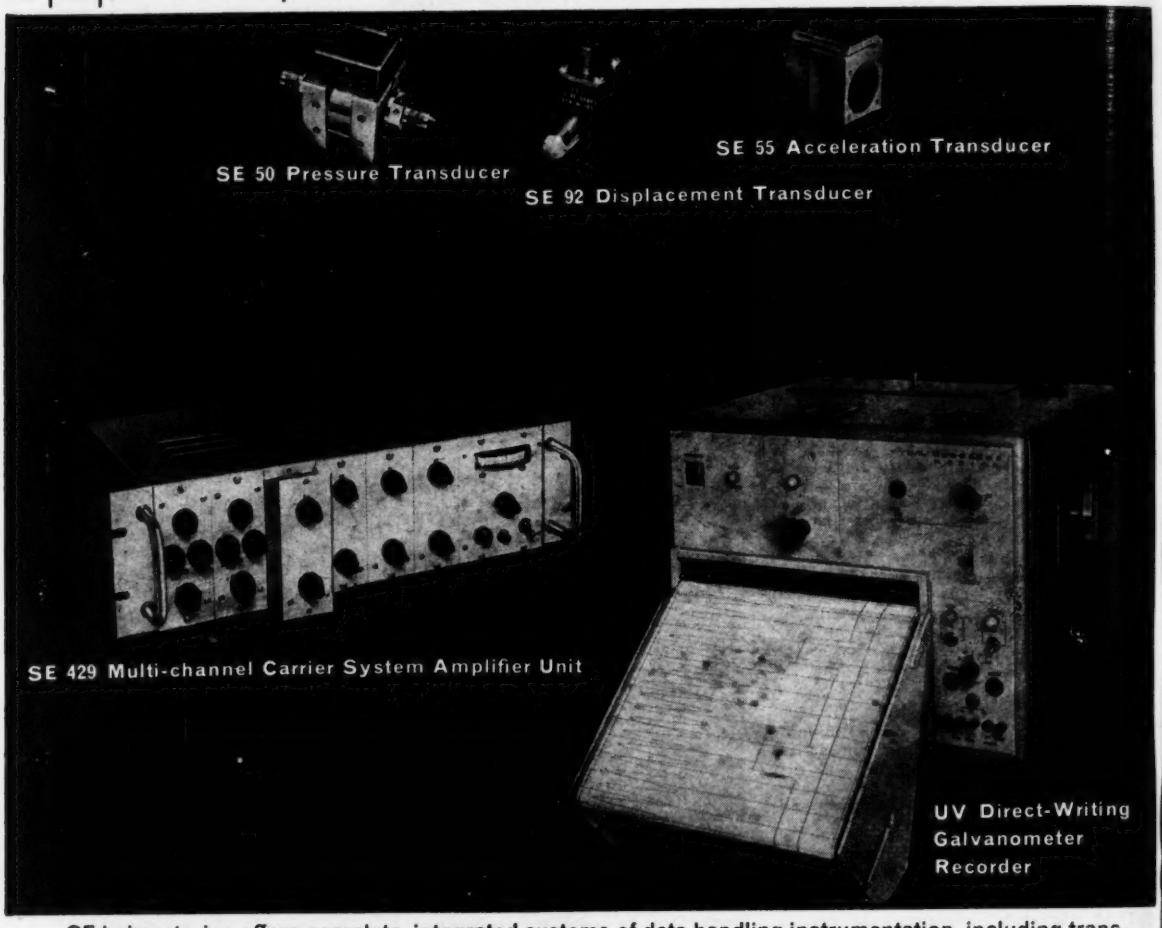
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Racal Instruments electronic digital integrator for use with gas chromatographs has been designed and built for installation in the Kirkuk refinery of the Iraq Petroleum Co.

other products in the Commonwealth of Australia and mandated territories.

The new company will work in close co-operation with Commonwealth Electronics Pty. Ltd., of Baulkham Hills, Sydney, who have made accommodation available to Racal.

The managing director of Racal (Australia) Ltd. is Mr. R. S. Hope, who is also managing director of Commonwealth Electronics Ltd.

RECORDING, indicating and control equipment has been supplied by **Honeywell Controls Ltd.** to Petroleos Mexicanos for the new Madero Petroleum Refinery in Mexico. In the U.K., McKee Head Wrightson Ltd. performed engineering services for this refinery.

Over a hundred miniature pneumatic Tel-O-Set recorders and controllers will monitor and govern temperature, flows, pressures, and other variables in the akalation and asphalt units of the new plant.

IN order to investigate the possibility of increasing exports to Japan, Mr. F. C. Crosse, a director of **Parkinson Cowan International Ltd.,** has just completed a six-week tour of markets in the Far East. The major part of his time was spent carrying out a market survey reconnaissance for all Parkinson Cowan products covering the gas, liquid and electrical industrial and domestic fields. Mr. Crosse also visited Hong Kong, Singapore and Australia, returning to London via New York.

WITH the prospect of Britain entering the Common Market, directors of the overseas companies and associates of the Production - Engineering Group visited London during the middle of September to discuss **"Operation Common Market".** Countries represented included Australia, Canada, South Africa and various West African and European areas. Lord Runciman, chairman of the Production-Engineering Group, presided at the meetings.

THE Motor and Control Gear Division of Associated Electrical Industries Ltd. has obtained an order from Constructors John Brown Ltd. for eighteen **control centres** valued at approximately £70,000. The equipment will be used to control the electric motors in two projected Russian detergent plants, one at Volgadonsk and the other at Shebekino.

AVO has been awarded a contract to supply 1,000 **Multiminor Model 2** measuring instruments to Indonesia. The company have, at the moment, a mobile demonstration unit, carrying the full range of electrical, electronic and nucleonic test equipment manufactured by them making a tour of Western Germany, Italy, France, Switzerland and Yugoslavia, offering a full technical sales and advisory service.

THE first 200 **portable double beam oscilloscopes,** DC.1014, developed and manufactured by Solartron, have been air shipped to the Los Angeles plant of Packard Bell Electronics Corp., following the licence to manufacture, granted to Packard by Solartron.

Quickfit and Quartz Ltd. has received their third order from the University of Mexico. The order, worth over £2,200, is for 320 laboratory assemblages.

SERVICE

ENGLISH ELECTRIC have now installed their first production KDP10 **data processing system** in a new commercial bureau at the company's Data Processing and Control Systems Division. The new bureau will be complementary to the existing centres at Kidsgrove and at Queen's House, Kingsway, where three English Electric Deuce computers are already available for commercial, industrial and scientific work.

EDUCATION

TWENTY-FIVE scientists from five countries have recently completed the first summer school in **Infra-red Spectroscopy,** organised by Unicam Instruments Ltd.

The two-weeks' course included practical sessions on the Unicam range of spectrophotometers in the company's new applications laboratory and a series of lectures on theoretical aspects of the subject.

Left to right: Peter Still, Victor Davis and Royston Smith, the first three apprentices to complete their five-year apprenticeship under the Engineering Industries Group Apprenticeship scheme at K.D.G. Instruments Ltd., receiving congratulations and a copy of the Engineers Handbook from their managing director, Mr. E. W. Stow.

RICHMOND milling machines, manufactured by Midgley & Sutcliffe Ltd., are being used to train **technical students in Syria,** studying under the United Nation's Children's Fund. Two of the 03SD plain milling machines, chosen by the UNICEF Paris headquarters, were shipped to Syria within weeks of receiving the order, proving so popular that an order has been placed for two more such machines.

THE SOLARTRON ELECTRONIC GROUP have started a series of **instructional courses** to impart the latest knowledge to the service engineers from their overseas companies and agents, ensuring that they are kept fully trained in the servicing of Solartron equipment.

THE high standard of training at North Gloucestershire Technical College and the success of techniques employed in the Dowty Group's recent apprentices' **training scheme** has resulted in three out of a total of ten B.Sc. first-class honours degrees and two second-class honours in mechanical engineering, together with one first-class honours in the Diploma of Technology.

ASSOCIATIONS

AT the annual general meeting of **The British Computer Society** the annual prizes for published papers were awarded to Dr. H. H. Rosenbrock (Automatic Control Engineering Ltd.) for his paper "An automatic method for finding the greatest or least value of a function", and to Mr. A. J. Platt (Pilkington Brothers Ltd.) for his paper on "The experience of applying a commercial computer in a British organisation".

AT the request of the National Aeronautics and Space Administration and the Federal Aviation Agency, a British research team from the D.S.I.R.'s **Road Research Laboratory** at Crowthorne have gone to America to assist in testing skidding resistance at high speed on an airfield runway at Atlantic City.

Large-scale investigations of the distances required by aircraft to take-off and land on wet or slush-covered runways are being undertaken.

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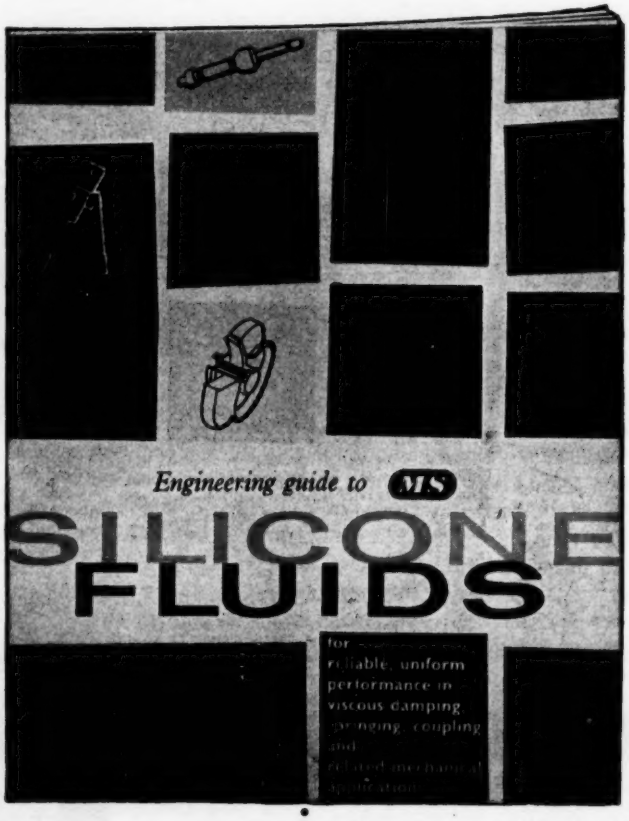

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At the **First Annual General Meeting of the B.C.A.C.,** held at The Institution of Electrical Engineers, the chairman, Sir Walter Puckey, recalled that some twelve months ago the B.C.A.C. had been reconstituted in its present form and he then presented the Annual Report of the Executive Committee on the year's work. This was received with approbation; in particular the setting-up of informal panels of interested experts concerned respectively with education and training, foreign relations, public relations, and research and development, was endorsed.

The annual accounts were presented by the honorary treasurer, and were approved and adopted; the subscriptions of the Member Societies for the year commencing 1st January, 1962, were fixed, as before, at £20.

Following the meeting, the First Annual Lecture of the B.C.A.C. was delivered before an audience drawn from the thirty Member Societies and including others present by invitation. Dr. D. G. Christopherson, O.B.E., F.R.S., vice-chancellor of Durham University, delivered the lecture, taking for his subject "Mathematics—Friend or Foe?" The meeting was opened by Sir Hamish D. MacLaren, K.B.E., C.B., D.F.C., LL.D., B.Sc., President of The Institution of Electrical Engineers, on behalf of the Host Institution; Sir Walter Puckey, as chairman of the B.C.A.C., presided.

An organisation, known as the **European Technical Pneumatic Controls Commission,** has been formed to enable the economic problems connected with oil hydraulics and pneumatics to be treated by a communal economic commission. Among the countries involved are Germany, Sweden, Netherlands, France, Belgium and England. Col. R. W. W. Taylor, managing director of Lang Pneumatic, has been appointed vice-chairman of the Commission.

The Coil Spring Federation Research Organisation has now been admitted to full membership of the government's industrial research association scheme under the title of "The Spring Manufacturers' Research Association".

RESEARCH

Scientists at the Westinghouse research laboratories have developed a **superconducting magnet.** For its size, weight and energy consumption it is by far the most powerful magnet ever built.

The new Westinghouse magnet is an electromagnet wound from a wire which is a superconductor. These are materials which lose all electrical resistance at temperatures near absolute zero (459 degrees below zero Fahrenheit). Once started, super-currents of electricity flow through superconductors forever without loss in strength.

Only the size of a doughnut and a pound in weight, the Westinghouse super-magnet creates a magnetic field twice as strong as that from a conventional iron-core electromagnet, 20 tons in weight, and operated to saturation of the iron.

In contrast, the new super-magnet runs from an ordinary automobile storage battery. The power the battery continuously supplies is only a few watts to overcome the small losses in power in the wires leading to it.

The superconducting magnet produces a magnetic strength, or flux density, of 43,000 gauss. It has no iron core. Iron-core magnets begin to saturate at about 20,000 gauss. They can be driven to greater strengths only by the application of large amounts of power that force them beyond saturation. Their coils would melt almost instantly if not for thousands of gallons of cooling oil or water pumped through them each minute.

The superconducting magnet contains a half-mile of niobium-zirconium base alloy wire which carries a current of 20 A.

About 5,000 turns of the wire are wound into a solenoid, 2 in. in diameter, 1½ in. long, and with a "hole in the doughnut" of ½ in.

The coil is immersed in a vessel of liquid helium which keeps it at a temperature near −450°F. The energy required to cool the coil is only a small fraction of that needed to create a comparable magnetic field with a standard electromagnet. Essentially, therefore, the magnet produces almost all of its super-magnetism "for free".

Westinghouse Electric International Co., U.S.A., have developed a method of producing **large single crystals of tungsten** of high purity and density. Tungsten rods 10 in. long and 0·2 in. diameter are being produced as single crystals and a purity of up to 99·9975% is possible. These pure single crystals are ductile even at temperatures as low as −330°F.

The development of the large single crystals of tungsten was the result of the need of Westinghouse research engineers for more knowledge about the fundamental properties of tungsten, which is a key component in products of the lamp, electronic, and missile industries. Tungsten metal, suitable for such studies, was not available, so Westinghouse engineers designed zone melting equipment using the electron beam principle of heating in order to produce bigger and superior crystals. However, to attain the ultra-pure single crystals, it was necessary to first develop a process for making special high purity tungsten ingots. These high purity ingots are used in the zone melting process as the starting material from which the single crystals are grown.

The single crystal tungsten is available commercially.

The Carl Zeiss Foundation of Western Germany have introduced new developments in the **cutting, welding and drilling of a variety of materials** including hard metals and jewels **by means of electron beams.** The processes employ an electron beam which is used to fuse material or to remove its surface by vaporisation. According to the manner in which it is used, the effect is one of welding, milling, cutting or drilling.

Since these processes take place *in vacuo,* zirconium, tungsten and other materials which hitherto were difficult or even impossible to work can now quite easily be treated. The electron beam has an energy density of 500 MW per sq. cm and is so finely controlled that it will melt a sharply-defined spot of 0·003 mm diameter which makes it particularly suitable for drilling jewelled bearings for delicate instruments.

Because short radiation impulses of very high density are used, surrounding material is in no way affected, this, of course, results in a very high degree of precision.

Used in the manufacture of electronic components such as resistors and transistors, the electron beam can, for example, cut a fixed pattern of fine slits in a very thinly deposited layer of metal.

The Research Laboratory of U.S. General Electric has discovered methods which make it possible to produce **semiconducting diamonds.** Such diamonds are extremely rare in nature, but can now be grown at will in the laboratory using the high-temperature, ultra-high pressure process first developed by GE.

Semiconducting borazon has also been successful. Borazon, which is a cubic form of boron nitride, has a structure very similar to that of the diamond and is equally hard. It was first made at the Research Laboratory.

Diamonds are made semiconducting by adding impurities such as boron, beryllium or aluminium to the mixture of graphite and catalyst from which diamonds are made.

The mixture is subjected to pressures of about 1 million lb/in² and temperatures above 2,000°F. Under these conditions, diamonds form with concentrations of 1% or less of the desired impurity, and have electrical conductivities in the semiconducting range.

Semiconducting diamonds have also been prepared at the Research Laboratory by diffusing boron and aluminium into man-made or natural diamonds at high pressures and temperatures. All the semiconducting diamonds made so far have been p-type (positive current carriers). Both p-type and n-type crystals are necessary in transistors and other semiconducting devices, and a search for processes that will produce n-type diamonds is continuing.

Both p-type and n-type crystals can be produced in borazon and one type can be grown on to a "seed" of the other type to form p-n junctions; tests on such junctions have shown that they act as rectifiers. Beryllium as an impurity produces p-type borazon, and a number of substances including sulphur, silicon, many organic compounds, and potassium cyanide, result in n-type borazon when added to the synthesis mixture.

Plessey have for some time been working on the development and application of components suitable for use in space vehicles. At the Caswell Research Laboratories extensive work is being done on **miniaturisation and microminiaturisation** and three basic methods are being considered. These are the component substrate system, the deposited circuit technique and solid state circuitry. In the first method a range of components are produced in a flat form of standard dimensions with individual items differing only in thickness. The separate elements

are then stacked and interconnected so that a packing density of up to some 250,000 components per cubic foot can be obtained.

In the deposited circuit technique components are formed by chemical deposition or evaporation complete circuits being produced by changing the homogeneity of a piece of material, usually silicon, so that individual components are formed with the required parameters, and physically arranged so that they are resistively or capacitively coupled in the required manner. Packing factors of up to several million components in one cubic foot are anticipated with this method.

EXHIBITIONS AND CONFERENCES

More than 100 delegates from government and university research laboratories and industrial establishments throughout the United Kingdom and abroad came to the **Symposium on Photomultiplier Tube Applications,** held at E.M.I. House from 13th to 15th September.

Aims of the symposium were to exchange information on the application of photomultiplier tubes in a wide variety of scientific and industrial fields and to encourage discussion on the ways in which improvements can be made and new fields opened.

Percy Allaway, managing director of E.M.I. Electronics Ltd., welcomed delegates to the symposium and Jack Sharpe of E.M.I. Valve Division, in his capacity as chairman, opened the proceedings by giving a general introduction to photomultiplier tubes.

Mr. K. Rippon of Hilger & Watts and Dr. M. A. Ford of Perkin Elmer discussed the use of photomultiplier tubes in emission spectrometers and spectrophotometers. The growing importance of the vacuum ultraviolet in the former field was stressed, whilst it became evident that the spectrophotometer techniques for the measurement of the visual pigments in the living human eye was presented by Dr. W. A. Rushton, F.R.S., of the Physiological Laboratory, Cambridge. The use of tubes in the far u.v. was highlighted by Dr. D. W. O. Heddle of the University College, London, who described in some detail his work utilising satellite-borne observing instruments. The growing importance of photon counting as a means of achieving the highest possible sensitivity from photo-electric and colorimetric applications was brought out by Professor D. E. Blackwell of Oxford, and by Mr. G. T. Winch of the General Electric Co., Hirst Research Centre, who showed how the accuracy of measurements in photometry and colorimetry was being improved by this technique. Two applications of photomultiplier tubes in colour television were described. Mr. Oxenham of Sylvania Thorn dealt with the Zebra colour television display system, while Mr. Hacking of the B.B.C. considered the problems of the colour film scanner. Mr. R. W. Franklin of Crosfields Ltd. described an application of photomultiplier tubes in the Crosfield Scanatron which, while basically a flying spot scanning system, calls for tubes of somewhat different parameters from those required by Mr. Hacking.

In a discussion of the nucleonic field, Mr. R. B. Owen of A.E.R.E. Harwell gave a general survey in which he pointed out the importance of photo-electron utilisation and the time characteristics of multiplier tubes. Mr. V. A. Stanley of E.M.I. described the company's work on the development of photomultiplier tubes for tritium counting and Mr. J. R. Brown, also of E.M.I., discussed the design requirements for large area detectors for alpha particles. An interesting application of photomultiplier tubes in the R. W. Gunson seed sorter was outlined by Mr. E. M. Worster of E.M.I. Electronics Ltd., using information kindly provided by R. W. Gunson.

The joint theme of Britain's first International Exhibition of **Space Research and Technology,** which will be held from 2nd to 11th May, 1962 as part of the Power Generation and Clean Air Equipment Exhibition, will be the relationship between industrial power on earth and the exploration of space. New metals and new materials, ceramics, plastics, refractories, new and conventional fuels (including automatic fuels) will be shown. So will engines, generators, boilers, furnaces, electronic and electrical controls, nuclear and conventional power plant with all its ancillary mechanisms, such as pumps, compressors, fans, heaters, valves and gauges, piping and insulation.

The **First International Heating, Ventilating and Air Conditioning Exhibition** occupied stand space of more than 75,000 square feet covering the whole area of the three floors of the Empire Hall of Olympia. There were 220 exhibitors from the United Kingdom and ten countries overseas.

During the ten days that the Exhibition was open, a total of 45,476 people visited it. There were 1,345 visitors from 60 countries overseas.

Leading Czechoslovak materials handling specialists visited Simon Engineering Ltd. at Cheadle Heath, during the course of a fact-finding mission to this country organised by the British Council for the Promotion of International Trade. Among the eleven visitors led by Mr. Josef Vyskoc, first vice-president of the State Committee for Technical Development, were representatives of several government ministries and state planning organisations. Mr. P. W. R. Jolley, sales director of Simon Handling Engineers, is seated right.

The Institute of Physics and The Physical Society is arranging a **conference on "Diffusion and mass transport in solids"** to be held in the University of Reading on the 10th and 11th of April, 1962. A number of papers have been promised and further contributions will be considered. It is provisionally proposed to hold sessions on general theoretical aspects of diffusion in solids and on diffusion and related mass transfer phenomena in metals, in oxides and covalent materials and in strongly ionic solids.

Correspondence regarding the programme should be addressed to Dr. B. L. Evans, J. J. Thomson Physical Laboratory, Whiteknights Park, Reading, Berks.

The conference will be residential and the numbers will be limited. Further particulars and application forms will be available in January, 1962, from the Administration Assistant, The Institute of Physics and The Physical Society, 47 Belgrave Square, London, S.W.1.

Machine tool users, designers and research workers from fourteen countries attended the **Second International Machine Tool Conference** organised at the Manchester College of Technology, by the Conference Organising Committee at the end of September.

Among the many papers presented were "A Continuous Path Machine Tool Control System using Coarse Optical Gratings", "Recent Developments in Moiré Fringe Measurement Systems for Machine Tool Control," "Widening the Applications of Diffraction Gratings for Measurement and Control" and "Ferranti Mk IV Continuous Path Phase Control System."

During the **Conference of European Postal and Telecommunications Administrations,** held in Torquay during the middle of September, experts discussed the latest developments in automatic letter sorting and the automation of the postal accounting operations.

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Prior to the pending completion of new premises the offices of **Cawkell Research and Electronics Ltd.** have moved to 99 Uxbridge Road, Ealing, London, W.5. Tel.: Ealing 6215/7585.

C. A. Norgren Ltd. London office, 39 Eccleston Square, London, S.W.1. Tel.: VICtoria 0891.

C. A. Norgren Ltd. Manchester office, 1 Davenport Avenue, Withinton, Manchester, 20. Tel.: Didsbury 1899.

Simmonds Aerocessories Ltd. Birmingham Midland Area Sales Office, Herbert House, Cornwall Street, Birmingham. Tel.: Birmingham Central 2248-9 and 2719.

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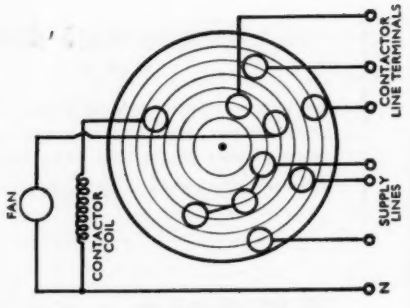

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A41

INSTRUMENT APPLICATIONS

New Furnaces for Automobile Components Production

SEVEN new heat treatment furnaces recently installed at the Leamington factory of Automotive Products Co. Ltd. incorporate continuous control and recording equipment supplied by Honeywell Controls Ltd.

Instruments control the temperature of an electrically heated shaker hearth furnace supplied by Wild-Barfield Ltd. A circular scale instrument controls zone one at the loading end of the furnace and a continuous strip chart instrument records and controls the temperature of the components in zone two immediately before they are dropped into the oil quench. Safety devices built into the instrument control the admission of the endothermic atmosphere gas to the furnace; additional protection to both load and furnace against over-heating is provided by the Protect-O-Vane safety units incorporated in each zone. Components quenched in this furnace emerge as bright as they were when loaded.

A continuous strip chart recorder controls and records the temperature of both zones of a gas fired continuous cast link conveyor furnace, used for oil quenching automobile clutch forgings. The furnace, supplied by British Furnaces Ltd., has a nominal capacity of 7 cwt per hour.

A separate panel controls three gas-fired furnaces for tempering and two gas-fired furnaces for normalising, all of which are supplied by British Furnaces Ltd.

The tempering furnaces are of the air circulating type. The two-point recorder records and proportionally controls the air temperature immediately before admission to the load and immediately after leaving the load. When these two temperatures are the same, timing devices are automatically started by the Honeywell equipment, thereby guaranteeing a correct time temperature cycle for each load tempered. Automatic Protectoglo units are fitted to give full protection against explosion. Protect-O-Vane units also play an important part in the automatic control cycle, the furnaces operating at temperatures between 550°C and 650°C.

The normalising furnaces working at 900°C are used for the treatment of forgings to give the required metallurgical condition and consistent machinability. Work is transferred from the furnaces to fast cooling air blast units.

The new automation has been designed to give pre-set automatic process control that gives improved quality and enables maximum plant utilisation to be regularly achieved.

Automatic Programming System for Steel Industry

A NEW automatic programming system for steel rolling mills has been developed by the Metal Industries Division of English Electric. The new system uses punched cards to store "rolling programmes", the complete sequence of screwdown, manipulator and mill speed settings and the number of passes in a rolling operation.

The system is an advance on the uniselector system introduced by the company two years ago. It offers a greater programme storage capacity than can be economically obtained with uniselectors.

The benefits are the same: the operator, relieved of the routine rolling, can do his job better and more easily, producing during his shift more steel of more consistent quality. He can always take manual control to correct rolling faults.

The first installation of the new system is at the Hallside reversing billet mill of Colvilles Ltd., where it is controlling the screwdown.

The complete system consists of three basic units: a card store, a card punch and a card reader..

The cards and card store

The cards, of tough plastic 1/32 in. thick, can be supplied in nine different colours, each with an identification tab. The front end of the card is notched. The special storage case can hold 100 cards.

Card punch

The unit is hydraulically operated. Keys remain depressed so that they can be checked before a complete line is punched.

Cards can be punched to user's specification if a punch is not required.

Card reader

All the information necessary for one pass of the mill may be stored on a double line on the card, which is advanced section by section for each pass. This method of operation avoids the need for an intermediate memory store, since the pass information remains under the reader for as long as it is required.

The sensing devices are photo-transistors, the output from which is amplified by a transistor amplifier controlling a small plug-in relay. The relays operate the various position control systems. All components except the relays are mounted in a standard plug-in Datapac unit of the printed circuit type.

Faulty units can be located by a test card. There is a parity check on all operations.

A card can be advanced through the reader either by single passes or as a complete rolling operation. After completing the programme, the card can be used again or rejected as required.

Crystal Clock using a Tunnel Diode

A CRYSTAL CLOCK, developed at a laboratory of U.S. General Electric, is accurate to within ±5 seconds per year.

The clock uses the high frequency oscillations of a quartz crystal and three tunnel diodes to convert the 100,000 c/s crystal vibrations to 50 c/s current. Because little power is needed by the diodes and the special GE clock motor, the clock can operate for months on a mercury battery (about the size of a standard torch cell).

The tunnel diodes have proved so stable in operation that no inaccuracy in the clock can be ascribed to them. The only source of variation is the quartz crystal, which changes frequency very slightly with changes in temperature. So far this has amounted only to about five seconds per year over a wider temperature range than would be expected in normal conditions of use. By regulating the temperature, and perhaps by further refining the electronic design, even greater accuracy would be possible.

GE report no plans for commercial production of the timepiece.

Data Logging System Applied to Wind Tunnel

A TRANSISTORISED data logging system capable of reading information from 100 transducers every second by a fast sequential scanning process is being developed by Mullard Equipment Ltd. It will be used at the Royal Aircraft Establishment, Farnborough, to examine the behaviour of models in a high speed wind tunnel which simulates flight conditions at very high mach numbers.

Wind tunnel tests frequently involve as many as 50 different transducers—strain gauges, thermocouples and so on—and it is essential that these are scanned as rapidly as possible so that significant variations of strain, temperature, pressure, etc., are not missed.

The system performs five basic functions: scanning, amplification, digitisation, coding and presentation. A number of scans are made during a test run, which may last for just a few seconds or as long as a minute. The information gathered from the various transducers is first amplified and digitised and then recorded on magnetic tape in a five-unit code. After the run, the results can be immediately recorded by a teleprinter, or the magnetic tape used as the input medium to a computer.

Built-in facilities are provided for checking that the system is operating correctly.

The system has many other applications, for example, in aircraft engine testing and industrial process control. Since it is largely built up from standard sub-units, equipments can be readily designed to suit the particular needs of the user.

Circle **363** for further information

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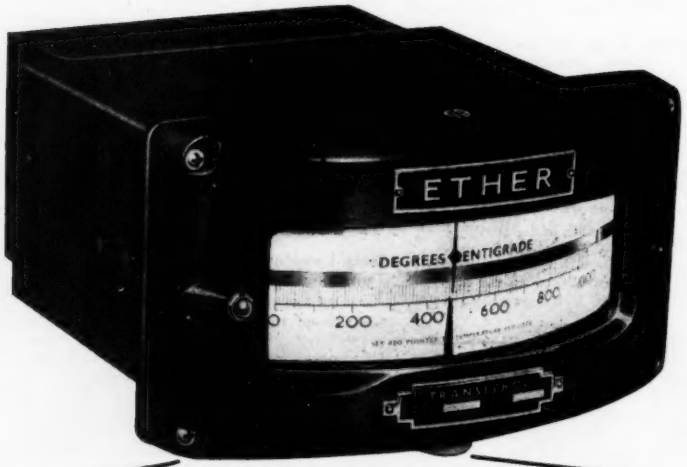

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Operating:
Solenoid valves.
Motorised valves.
Contactors. Relays.
Electric heaters.

Applications:
Salt-baths for heat-treatment of metals.
Vitreous-enamelling furnaces.
Muffle furnaces.
Hot-air ovens.
Drying kilns.
Crucible furnaces.
High-temperature alarms.
Extruding and moulding machines, etc., etc.

TYPE 991:
Anticipatory

Operating:
Solenoid valves.
Motorised valves.
Contactors. Relays.
Electric Heaters.

Applications:
Extruding machines and moulding presses for plastics, rubber, etc.

Die-casting machines.

Furnaces for crystal growing.

Chemical processing.
Food packaging machinery, etc., etc.

TYPE 992:
Proportioning (stepless)

Operating:
Saturable reactors.

Applications:
Electrically-heated equipment requiring extremely accurate temperatures, e.g. plastic extruders for high-quality production.

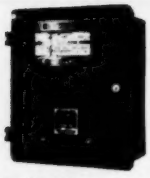
Electric furnaces employed on research.

Electronic production, etc., etc.

TYPE 993:
Three-position (employing any combination of the preceding control systems).

Operating:
Solenoid valves.
Motorised valves.
Contactors. Relays.
Electric heaters.
Saturable reactors.

Applications:
For the independent control of sequential heating and cooling or for controlling a floating valve in:—
Salt-baths for heat-treatment of metals.
Vitreous-enamelling furnaces.
Muffle furnaces.
Crucible furnaces.
Extruding machines.
Moulding presses.
Die-casting machines, etc., etc.



TYPE 995:
Continuously-acting Proportional (with manual reset)

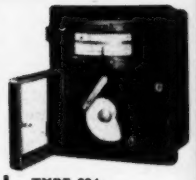
Operating:
Motorised proportioning valves.

Applications:
Gas-fired or oil-fired molten-metal vats.

Continuously-fed furnaces.

Lehrs.

Drying ovens and kilns, etc., etc.



TYPE 994:
Time-Temperature (employing any one of the preceding control systems).

Operating:
Solenoid valves.
Motorised valves.
Motorised proportioning valves.
Contactors. Relays.
Electric heaters.
Saturable reactors.

Applications:
For controlling the rise and fall of temperature over a given period o time in:—
Pottery kilns.
Food processing.
Heat-treatmentofmetals, glass, plastics.
Research, etc., etc.

PERSONALITIES

Dr. D. S. Beard

Mr. Eric Falkner

Mr. K. Gordon Sinclair, chairman of the Griffin & George Group of Companies, has appointed **Dr. D. S. Beard, Ph.D., A.Inst.P., A.R.C.S., B.Sc.,** to the board of Griffin & George (Sales) Ltd. in the capacity of technical sales director. He joined Griffin & George in 1960 from Norwich City College where he had been a lecturer of physics and mathematics.

Sir Willis Jackson, F.R.S., who since 1953 has been director of research and education of Associated Electrical Industries (Manchester) has relinquished his appointment to return to academic life as Professor of Electrical Engineering at Imperial College, University of London.

The Minister for Science, Lord Hailsham, has appointed five new members of the Council for Scientific and Industrial Research. They are **Mr. L. H. Bedford,** Director of Engineering, Guided Weapons Division, English Electric Aviation Ltd.; **Mr. G. B. R. Feilden, F.R.S.,** managing director, Hawker Siddeley Brush Turbines Ltd.; **Professor E. R. H. Jones, F.R.S.,** Waynflete Professor of Chemistry, Oxford University; **Professor O. A. Saunders, F.R.S.,** Professor of Mechanical Engineering, Imperial College, and **Mr. H. C. Tett,** chairman and managing director, Esso Petroleum Co. Ltd.

Three members who have completed their five-year term of office, retired at the end of September. They are the former chairman, Sir Harry Jephcott, chairman of Glaxo Laboratories Ltd.; Professor C. E. H. Bawn, F.R.S., Professor of Inorganic and Physical Chemistry, Liverpool University, and Sir Willis Jackson, F.R.S., formerly director of Research and Education, A.E.I. (Manchester) Ltd. A fourth member, Sir Walter Drummond, who was also due to retire, has been reappointed for a period of 3 months.

Mr. J. G. Wellings, M.I.E.E., consultant on instrument transformers at the Transformer Engineering Department of the A.E.I. Transformer Division, Rugby, retired at the end of September, after forty-six years' service with the company.

Mr. Wellings has been one of the company's representatives on the B.E.A.M.A., B.S.I., and I.E.C. committees; and was also a member for some years of the old Electric Discharge Lamp Auxiliaries Council's Technical Committee, as well as participating in meetings of the High Tension Conference in Paris.

Mr. E. A. Falkner becomes a director of Hairlok Laboratories Ltd., the design, development, research and testing division of the Hairlok Co. Ltd. Mr. Falkner, who was formerly research manager, has been with the company for twelve years, starting one of the first packaging research and development laboratories in this country, and also building up the design team responsible for advanced container and cushioning design for both commercial and full standard Ministry requirements.

British Aircraft Corporation Ltd. have made the following new appointments: **Sir George Edwards, C.B.E., B.Sc., Hon. F.R.Ae.S., Hon.F.I.A.S.** (executive director, aircraft), is now managing director of British Aircraft Corporation Ltd. He ceases to be managing director of Vickers-Armstrongs (Aircraft) Ltd. to become deputy chairman. **The Rt. Hon. Viscount Caldecote, D.S.C., M.I. Mech.E., M.I.E.E., A.F.R.Ae.S.** (executive director, guided weapons), is to be deputy managing director and chief executive (guided weapons) of British Aircraft Corporation Ltd. Marshal of the Royal Air Force **Sir Dermot Boyle, G.C.B., K.C.V.O., K.B.E., A.F.C.,** has been appointed to undertake special responsibilities for co-ordinating the administration, training and education of personnel within the group, and **Mr. A. W. E. Houghton, A.F.R.Ae.S.,** is now managing director of Vickers-Armstrongs (Aircraft) Ltd.

Mr. R. L. Higgin, A.M.I.E.E., formerly group commercial executive of Plessey Components Group, is now general manager of the Group. The Plessey Components Group operates factories at Ilford, Towcester, Sheffield and Havant.

Mr. L. H. Short, M.C., director of overseas operations of the English Electric Co. Ltd., has been elected chairman of the export panel of the British Electrical & Allied Manufacturers' Association. The panel, comprising leading specialists in the electrical industry on export matters, is the chief advisory body to the BEAMA council on overseas trade. Mr. Short has been vice-chairman of the panel for the past two years and succeeds Mr. E. V. Small, consultant to Associated Electrical Industries Export Ltd., who has been chairman for this period. The new vice-chairman is **Mr. H. P. Martin,** sales director of C. A. Parsons & Co. Ltd.

Mr. L. W. Bailey, of L. W. Bailey & Partners Ltd., representing the British Institute of Management, is to be the new chairman of the National Joint Committee on Materials Handling in place of Mr. G. C. Paterson, of Paterson Hughes Engineering Co. Ltd., who represented the Institute of Materials Handling.

Microcell Ltd. has appointed **Mr. F. Thomas Jones, A.M.I.Prod.E.,** as director and **Mr. J. A. Grace** as commercial director.

Mr. G. Cunliffe, managing director of Norcros Ltd., was elected president of the British Standards Institution at their recent annual general meeting in succession to Mr. R. E. Huffam, and chairman of the Institution's general council. Tributes were paid to Mr. Huffam for his three years' service in respect of the posts he had held. He was elected a deputy president.

Mr. A. D. Bonham-Carter, United Kingdom co-ordinating director of Unilever Ltd., succeeds Mr. Cunliffe as chairman of the Finance Committee. A further appointment was that of **Sir Anthony H. M. Bowlby** as chairman of the Engineering Divisional Council in succession to Sir Stanley Rawson, whose term of office had expired.

Mr. W. K. Brasher, secretary of the Institution of Electrical Engineers, has appointed as the first pubic relations officer **Mr. P. D. G. Heneker,** who for the past two years has been his personal assistant. Mr. Heneker joined the Institution staff in 1958 after spending four years with a British business house in Calcutta.

Dr. W. J. Bates, Ph.D., B.Sc., has joined R. & J. Beck Ltd. as chief engineer. He leaves Bristol University to lead Beck's design team and, pending completion of the company's new factory at Watford, will be at the Lister Works, Dickenson Street, London, N.W.5.

Mr. H. V. Disney, C.B.E., M.I.Mech.E., previously deputy managing director of the United Kingdom Atomic Energy Authority, has been appointed managing director of their engineering group due to the resignation, in 1962, of Mr. J. B. W. Cunningham, M.I.Mech.E. Mr. Disney took over the managing director responsibilities progressively together with the title of managing director (designate) on 1st November.

Following the purchase of A. C. Cossor Ltd. by Raytheon Co., of Massachusetts, U.S.A., the following members of the Raytheon Co. have been elected to the board of A. C. Cossor Ltd.

Mr. C. F. Adams (Chairman of the board of Raytheon).

Mr. R. E. Krafve (President of Raytheon).

Dr. C. L. Calosi (Vice-president of Raytheon).

Raytheon have already announced their intention of preserving the identity of the Cossor group. Major-General Sir Miles Graham continues as chairman, and Mr. J. S. Clark as managing director.

Mr. L. H. Welch, O.B.E., B.Sc.(Eng.), M.I.E.E., who recently retired from the position of chief electrical engineer to the London Electricity Board, has been appointed as industrial relations consultant to the Electrical Research Association.

Mr. Welch has been closely connected with the work of the E.R.A. for many years, especially with that on cables and insulating oils. He was also a member of many of the former E.R.A. committees concerned with these subjects and chairman of a panel responsible for urgent work on the utilisation of power cables.

Mr. W. S. Perkins, A.C.G.I., A.M.I.E.E., has been made divisional executive (Rugby) of the A.E.I. Transformer Division. He was previously manager of this department.

The English Electric Co. Ltd. have made the following changes on the boards of its subsidiary companies:

The Hon. George Nelson has been appointed chairman of Marconi Wireless Telegraph Co. Ltd. and has retired from the board of Marconi Instruments Ltd., and English Electric Valve Co. Ltd. He has relinquished his position of deputy chairman of Marconi International Marine Communication Co. Ltd., but remains a member of the board of that company.

Sir Gordon Radley has been appointed deputy chairman of Marconi Wireless Telegraph and chairman of Marconi Instruments Ltd., English Electric Valve Co. Ltd. and Marconi International Marine Communication Co. Ltd.

Lord Nelson of Stafford has retired from the chairmanship of Marconi Wireless Telegraph, but remains a director of the company; he has also retired from the chairmanship of the board of Marconi Instruments Ltd., English Electric Valve Co. Ltd. and Marconi International Marine Communication Co. Ltd.

Mr. Sutherland has been appointed deputy chairman of Marconi Instruments and **Dr. E. Eastwood** has been elected a director.

Mr. P. Horsfall has retired from the board of Marconi Instruments and English Electric Valve Co. Ltd.

Mr. D. P. Furneaux, the general manager of Marconi International Marine Communication Co. Ltd., has been elected a director and appointed managing director designate. He will take up his duties as managing director on 1st January, 1962, on the retirement of **Mr. R. Ferguson.**

Mr. A. V. Edwards, managing director, **Dr. F. W. Stoneman,** executive director, sales and engineering, and Major-General Cole, operational manager of the newly-formed Telecommunications Division of Ultra Electronics Ltd., recently visited the United States on a sales and development exploitation tour. During their tour they had discussions with **Dr. N. H. Jacoby** and **Dr. J. M. Petit,** the two American directors recently elected to the board of Ultra Electronics Ltd. Dr. Jacoby and Dr. Petit are both directors of Electronics Capital Corporation and Electronics International Capital Ltd. The latter, which holds a 40% interest in Ultra, nominated them as its representatives to the board.

Dr. Jacoby is Professor and Dean of the University of California and was vice-president and professor of the University of Chicago. From 1953 to 1955 he was a member of the President's Council of Economic Advisors in Washington.

Dr. Petit is Dean of the School of Engineering and Professor of Electrical Engineering at Stanford University, California. He was at one time assistant technical director of the American British Laboratory (U.S. Office of Science Research and Development) at Great Malvern.

Elliott Brothers (London) Ltd. has appointed **Mr. A. C. Jones, A.M.I. Mech.E., A.M.Inst.Fuel,** to the post of assistant general manager, within the automatic control valves group. Before joining the company, Mr. Jones was

Mr. A. A. Evans

manager of the Audco Controls Division of Audley Engineering Co. Ltd.

The following appointments have also been noted:

Aerostyle Ltd. general manager, E. Crisp.

Avo Ltd. works manager, D. Fowler.

B. & R. Relays Ltd. technical representative, A. Young (Northern Ireland).

Fisher & Porter Ltd., Southern Division, manager, D. Ambrose.

Plessey & Co. Ltd., Capacitors and Resistors Division, sales manager, A. A. Evans.

R. B. Pullin & Co. Ltd., Thermostat Division, area representatives, D. S. Crichton (Southern Area), P. K. Smith (Midland and South Wales Area), D. W. Brown (Northern Area). Traffic Barrier Division, sales manager, R. W. Jelbart.

Telequipment Ltd. chief development engineer, L. D. Kreps.

Texas Instruments Ltd. sales administration manager, J. White.

MANUFACTURERS' LITERATURE

Instrumentation

This publication, which is a technical information bulletin, issued quarterly by Marconi Instruments Ltd., contains articles on "Gamma Radiation Monitor", by A. A. Luskow; "Oscilloscope Preamplifier", by E. C. Crawford; and "Standardisation of Crystal Calibrators TF 1374 & TF 1374/1", by E. Isaacs.

Circle **89** *for further details.*

Nyaflow

Polypenco Ltd. have recently introduced to their range of industrial plastics a new pressure hose which is complementary to the existing range of Polypenco Nylaflow pressure tubing described in the company's leaflet NF-2.

Circle **90** *for further details.*

Timer Circuits

Technical Communication No. 16 from Britec Ltd. discusses timer circuits with "Elesta" cold cathode tubes. Suggestions are made on appropriate tubes, components and design, as well as a variety of new circuits.

Circle **91** *for further details.*

Data Leaflets

A series of data leaflets are now available from Punched Card Accessories Ltd., describing some of their new products. Leaflet No. 1 features the StorMost computer tape racking system. Leaflet No. 2 the uniform guide and header cards. Leaflet No. 4 the gearless tape winder/dispenser. There is also a brochure describing the PCA "3000" range of data processing ancillary equipment.

Circle **92** *for further details.*

Recorders

Catalogue No. 163 from James Gordon & Co. Ltd. gives details of the company's mono gas analysis recorders for two and three constituents, together with information on other types of mono recorders available.

Installation details and a number of diagrams are also included.

Circle **93** *for further details.*

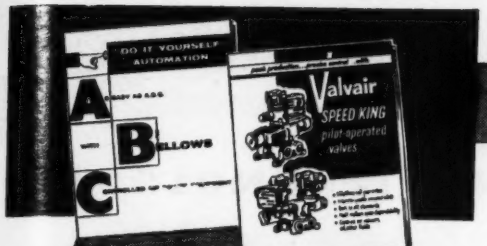
Automation & Process Control

Automatic Control Engineering Ltd., a wholly owned subsidiary company of Constructors John Brown Ltd., has grown, in the last few years, from a handful of staff to its present position as the leading independent company offering services in the field of automation and process control, so states the company in their recent publication. The company's products together with their applications to industry are described.

Circle **94** *for further details.*

(*Continued on page* 1466.)

Circle 364 for further information



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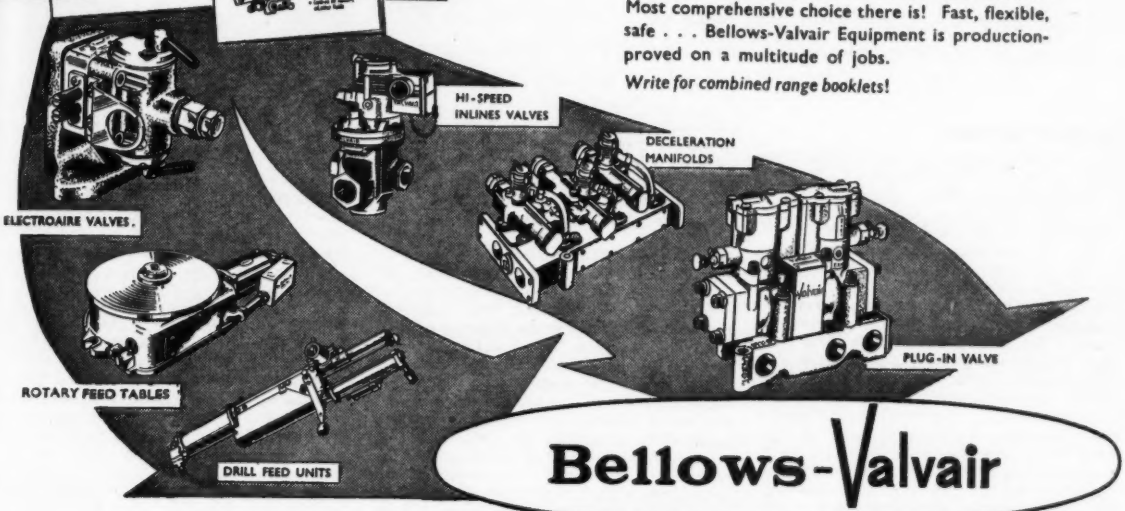

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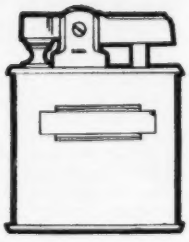

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In super purity, commercial purity or alloys

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SOCIETY OF INSTRUMENT TECHNOLOGY

Control Section

THE following papers will be read to the Control Section of the Society:

19th February, 1962.

"Digital position control of a large d.c. motor" by W. L. Marks, M.Sc.

A shaft position transducer producing pulses is used in conjunction with an arithmetic unit consisting of an absolute position register and an error register, together with a push-button address, to control the shaft position of a 50 hp mill type d.c. motor loaded to about 20 hp. The precision aimed at is $\frac{1}{4}$ of a revolution of the motor, irrespective of the number of revolutions, so that very high accuracies are available over a running period of, say, 1,000 revs. Measurements of the accuracy attained over several hours show that the accuracy is high and that it is considerably better than that obtained on an identical motor subjected to analogue position control.

"A digital position control for a steel mill screwdown" by I. A. Dempster, B.Sc., Ph.D., Graduate I.E.E.

The paper will commence with a general description of the normal manual control of the screwdown position. This covers the screws and associated gearing, the screws motors, the generators, excitors and main magnetic amplifier, current limit, and manual control input.

The main part of the paper will describe the additional equipment for automatic position control. This includes a programming unit and a position digitiser. Transistorised logical switching elements are used for digitiser ambiguity elimination, a twelve bit binary subtracter and a digital-to-analogue converter. For stability, a tachogenerator feedback and its derivative are used, these being summed along with the analogue error in a premagnetic amplifier. The second magnetic amplifier output is shaped in the circuit before the main magnetic amplifier, again for stability reasons.

21st March, 1962.

"Electro-hydraulic control of steelworks plant" by B. C. Wilkins.

The paper will deal with control systems involving digital logic elements and solid-state amplifiers operating rapid acting electro-hydraulic control valves to produce either discrete or continuously varying outputs. Several applications of the method will be described including mill screwdowns, furnace bogies, and other steelworks plant.

North Lancashire and Lakeland Section

ON 20th September the first meeting of the session was held at Blackpool. Well attended, particularly in view of the counter-attraction of the "lights", the meeting was opened by the chairman who briefly reviewed the events leading up to the formation of the new Section. He urged the visitors present to join the Society and to actively support its activities, then he introduced Mr. A. M. Burgess, of I.C.I., who presented his lecture on "Digital Tachometry".

Mr. Burgess outlined the available methods of measuring shaft speeds in both the analogue and digital fields and discoursed on the advantages and disadvantages of the methods available. He then concentrated on digital methods and explained where these were particularly applicable. Transducers and counting equipment were covered in detail and the lecturer had sample transducers for examination by the audience. He then rounded off his lecture by describing an optical transducer and ancillary equipment developed for a particular plant application.

The lecture, which was illustrated by sketches, was very well received and, after questions from the audience had been answered, a vote of thanks, proposed by the vice-chairman, was carried.

East Midlands

THE season opened at Loughborough College on 13th September, with a successful One-Day Conference on "The Application of Instrumentation to Industrial Processes, with Special Reference to the Problems of the Smaller Firm". The idea behind it was to introduce the manufacturers in the region to instrumentation, to tell them what is meant by the word, and to show them how their processes can be made more efficient by its use.

The conference was divided into seven lectures in three sessions and took the delegates through a sequential programme consisting of an introductory lecture explaining what it was all about; three lectures dealing with main topics, i.e. mechanical handling, temperature control, fluid control; one dealing with a more refined problem as an example for a detailed investigation involving the use and abuse of instruments; a lecture describing the principles and some of the pitfalls of instrument installation; and finally a survey of half-a-dozen practical cases involving instrumentation in as many industries, each case involving the use of relatively simple equipment to solve an apparently complicated problem.

In addition to the lectures, there was a display equipped by the lecturers themselves, and not by instrument manufacturers, showing working models associated with what had been said, examples of more complicated apparatus and of apparatus doing the same work but based on different principles. There was also a publications table on which were displayed several British magazines.

The meeting was directed and introduced by the chairman of the Local Section, Mr. P. Sears, and the closing address was given by the chairman of the Loughborough and District Productivity Association, Mr. S. G. Harmer.

It is interesting to study the list of delegates, for one sees that, apart from a number who were attracted from outside the region by the excellent publicity that was given in the trade and technical magazines and by various trade organisations, most were representing the dyeing and chemical trades. Some of these firms are already using a great deal of instrumentation, and very few were from the traditional East Midlands trades, apart from coal mining and agriculture, hosiery, knitwear, lace manufacture, and boots and shoes.

It seems that instrumentation has a long way to go in persuading a completely lay company of its value, but that once it has got a foothold, its value becomes clear and great interest is awakened in the users, who start looking out for further applications.

Perhaps to aim at this stage at the genuinely small firms is not the best plan. So many larger firms, with the capacity to experiment, are only just on the fringes of the technology at the moment that we should try to educate them to be leaders; the smaller firms will then follow. Our experiences with the conference lead us to think that perhaps a series of conferences aimed at the "newly converted" manufacturer would bear greater fruit than a continuance of attempts to reach the dedicated non-user.

South Yorkshire Section

THE first technical meeting of the 1961/62 session was held at the University, Sheffield, on the 4th September and was entitled "Automatic Gauge Control". The paper was presented by Mr. P. R. A. Briggs, the technical manager of Davy-United Instruments.

In introducing his subject, Mr. Briggs mentioned that a form of auto gauge control had been used in the United States for 25 to 30 years without too much success, this was because the system was direct-acting in that a form of thickness gauge provided a signal which directly actuated the rolling

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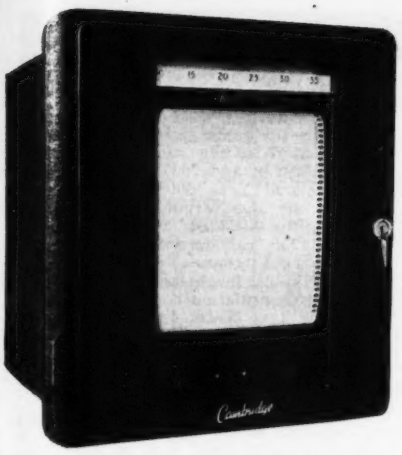

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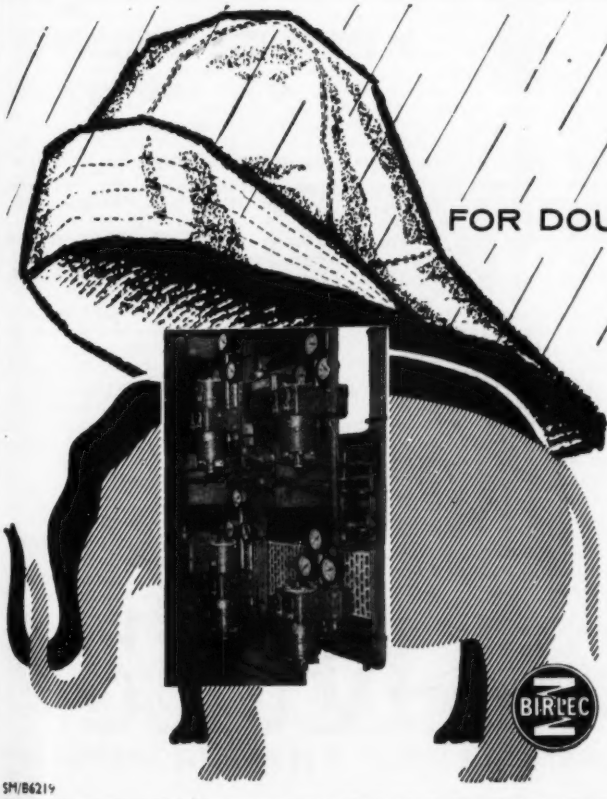

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Dry compressed air might well find an application in the Elephant House but, in this instance, we refer to the paper industry—in the application illustrated, the Reed Paper Group's Aylesford Paper Mills are using Electroflo Process Controllers operated by compressed air, dried by Birlec Air Drying Equipment.
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mill screws. At that time servo control was in its infancy and it was only after the war, when the great advances that had been made in servo techniques became available commercially, that automatic gauge control became a practicable proposition.

Normally, A.G.C. was only applied to cold rolling mills mainly because the theory of hot rolling is not as well known as that of cold rolling and because the screw movement is very much larger in the former process. It is also further complicated by the fact that the end of the bar is considerably colder than the beginning and therefore requires a very much greater roll pressure to achieve an equivalent reduction in thickness. The system must be reset ready for the next bar, otherwise the high pressure required at the cold end of the preceding bar would reduce the hot end of the next bar below the required thickness.

Dealing with the cold rolling of steel strip and sheet, Mr. Briggs then dealt with the development of A.G.C. to its present level. The most simple method is to use a conventional thickness measuring device such as a "Flying Mike" which produces a voltage proportional to error about the set point, this voltage is then amplified and applied to the screw-down motor. The big disadvantage of this method is that the measurement is made at a point remote from that at which correlation is applied and, since the separation is of the order of 3 to 8 feet, several seconds must elapse before the effect of the corrective action is felt at the sensing element. This delay, or transport lag, is not too serious at high rolling speeds, but at low speeds can lead to considerable wastage in "off-gauge material".

To overcome this drawback a sampling control was evolved, in which the strip is measured and, if necessary, corrective action applied for one second, after which the strip is re-checked and a further one second correction applied. To cope with varying mill speeds the "off" time of the sampling mechanism is automatically varied inversely to mill speed.

The lecturer then dealt with the sensing elements commonly employed. The contact devices such as the "Flying Mike" tend to mark the material and to lose contact at strip speeds in excess of 1,000 ft/min. They also needed to be kept hot with steam to prevent drift in locations where large thickness reductions resulted in a high strip temperature. Air blast cooling was found to be singularly ineffective in preventing drift.

Non-contact gauges depended upon the absorption of X-rays, β particles or γ-rays by the material, being proportional to thickness. The former is the most flexible, β particles can only be used for material up to 0·045 in., while γ-rays can be used from 0·050 in. to 2·0 in.

All these devices can give rise to transport lag trouble, but sampling techniques coupled with a large tolerance setting of the apparatus for the first pass, reducing to a fine one for the final pass, can largely overcome this difficulty. If there were no tolerance zone the screws would be in a continual state of motion which would cause considerable wear at or about the set point. The use of the tolerance zone tends to overcome this difficulty and to equalise the amount of wear on the screws.

Recent developments tend to measure the strip thickness at the point of reduction, i.e. at the actual work rolls. If the mill were of infinite stiffness a roll gap of 0·030 in. would produce a finished strip of 0·030 in. In fact, however, the mill is elastic and therefore the true strip thickness is increased by a factor proportional to the mill elasticity. Since the elasticity or modules of the mill is constant the thickness can be expressed in the form of an equation: $\frac{F}{M} + S_o = h$: where F is the total roll force, M mill modulus in tons per inch, S_o is the initial roll opening, i.e. the movement from zero, and h the required strip thickness.

By putting a pressure-sensing device between the mill screw and the chocks it is possible to measure F, and during the initial running-in period the modulus M is determined for the particular stand.

Selsyns are coupled to the screws and the resultant signals are fed back to an electronic cabinet which reduces the error signal to screwing action. This system eliminates transport lag and can measure an error of up to 10^{-4}. As the mill warms up, the roll and mill dimensions change, this would cause the zero to shift, but this is overcome by using a normal thickness gauge which is used to correct the zero and eliminate the effect of these changes.

The biggest problem in this type of control is that of roll eccentricity, when it is considered that the back up rolls may be up to 50 in. in diameter and the work rolls between 15 in. and 18 in. It is impossible to grind to an accuracy of better than 0·025 in. There are also bearing eccentricities and the control system can measure up to a fraction of one thousandth of an inch. This eccentricity can be overcome to some extent by applying a time delay circuit to the controller so that it does not respond to the eccentricity pattern, but at slow speeds there is still a pattern of eccentricity. This, however, is not serious and the finished strip is vastly superior in quality to that produced by manual control.

The lecturer then showed a series of traces which clearly demonstrated the effectiveness of A.G.C. in determining strip quality. The lecturer emphasised the application of the control of which he had been speaking related to a single stand reversing mill, the problem achieved a much greater complexity when applied to a three stand tandem mill, because the strip speed varied from one stand to the next, due to the reduction in cross-sectional area. Since most mill operators will not allow sensing elements between stands, due to the possibility of damage by flexure of the strip, it is usual to apply A.G.C. to the first and last stands only. Fine control can be applied to the last stand in the form of speed alteration which provides vernier control on the strip thickness.

The interest that had been aroused by the lecture was evident by the lively discussion that followed.

The chairman congratulated Mr. Briggs on the quality of his paper.

(*Continued from page* 1462.)

Isotope Developments Ltd.

The latest literature from the company includes preliminary information on their automatic sample counting assembly, Types 2027A and 2027B cylindrical lead castles and Type 6003 Isotope carrier. There are also various data sheets describing the following: Precision ratemeter Type 1750, ratemeter Type 1815, scaler Type 1805, timer Type 1860, single channel pulse height analyser Type 1870, tritium scintillation counter Type 6012. All the data sheets have their appropriate specification details.

Circle **95** *for further details.*

Dust Meter

Catalogue No. 170 issued by James Gordon & Co. Ltd. describes their Konitest dust meter, the latest addition to the company's range of equipment.

Circle **96** *for further details.*

"Commonwealth Digest and World Economic Review"

Published in London by Economic Digest (Publications) in association with the Economic Research Council, the July, 1961, issue of this publication contains an article on Sir Edward Boyle. Also featured in this issue are the common market, and government spending.

Circle **97** *for further details.*

Valves

G. A. Platon Ltd., sole British agents for Research Controls, Tulsa, U.S.A., have recently issued a four page leaflet on miniature instruments and controls for pilot plants, research laboratories and process industries. In particular, mention is made of Minim flow valves and typical research control valves. Flow charts for liquid and gases together with a steam chart are included.

Circle **98** *for further details.*

Carl Zeiss Works Magazine

In the current issue of the Carl Zeiss Werkzeitschrift articles of interest are as follows:

"Electron Beam Tools of Modern Technology" by K. H. Steigerwald, "Use of Low-magnification Luminars for Survey Photographs" by Dr. J. C. van de Kamer, "Use of Optical Measuring Instruments in Breweries", and an article by Professor M. Diem "Concerning the Measuring Technique of Cloud Structure and Precipitation".

The magazine is published in English by the Carl Zeiss Foundation and is available from the company's U.K. agents, Degenhardt & Co. Ltd.

Circle **99** *for further details.*

Kodak Professional Catalogue

This 214-page catalogue from Kodak Ltd. provides, in easy-reference form, information about the salient features, sizes, prices and stock availability of Kodak material and equipment for commercial, industrial and portrait photography.

Circle **100** *for further details.*

(*Continued on page* 1468.)

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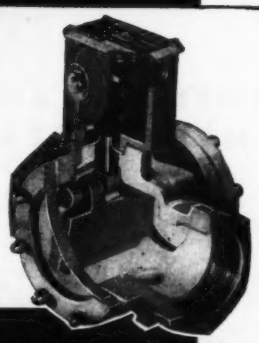

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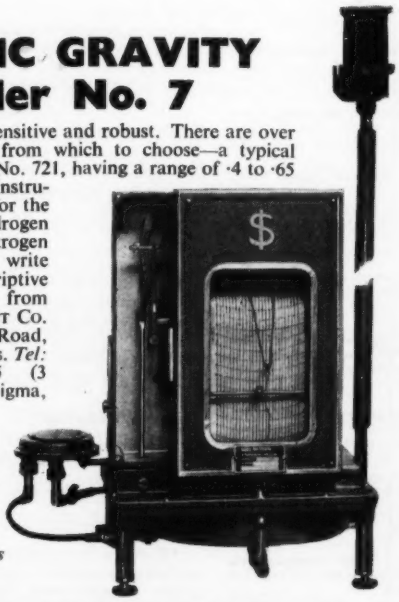

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FORTHCOMING EXHIBITIONS AND CONFERENCES

Nov. 7th–12th. **6th Congress and Exhibition.** Automation and Instrumentation, Milan, Via del Politecnico, 10. ("Automazione e Strumentazione", Via Marcona 15, Milano).

Nov. 8th–10th. **Conference on Non-destructive Testing in Electrical Engineering.** London. (Secretary, I.E.E., Savoy Place, London, W.C.2.)

Nov. 13th–16th. **First National Maintenance Conference & Exhibition.** Central Hall, Westminster, London.

Nov. 13th–16th. **Meters, Gauges and Measuring Instruments Exhibition.** Old Horticultural Hall, London. (Metro Trade (Exhibitions) Ltd., 67-9, Chancery Lane, London, W.C.2.)

Nov. 13th–18th. **Engineering Materials and Design Exhibition and Conference.** Earls Court, London. (Industrial & Trade Fairs Ltd., Commonwealth House, 1-19, New Oxford Street, London, W.C.1.)

Nov. 13th–18th. **International Factory Equipment Exhibition.** Earls Court, London. (Industrial & Trade Fairs Ltd., Commonwealth House, 1-19, New Oxford Street, London, W.C.1.)

Nov. 14th–Jan. 1st., 1962. **Indian Industries Fair.** New Delhi.

Nov. 15th–29th. **Building Exhibition.** Olympia.

Nov. 22nd–27th. **Fifth Conference and Exhibition of Automation and Instrumentation.** Milan.

Nov. 23rd. **Conference—Efficiency in the Office.** Connaught Rooms, London, W.C.2. 9-45 a.m.—5 p.m. (British Institute of Management, Management House, 80, Fetter Lane, London, E.C.4.)

Nov. 27th–28th. **Exposition of Chemical Industries.** New York.

Nov. 27th–30th. **Corrosion and Metal Finishing Exhibition.** Olympia.

Nov. 29th. **Conference on Oil Hydraulic Power Transmission and Control.** Institution of Mechanical Engineers. (The Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1.)

Nov. 30th–Dec. 1st. **Nuclear Electronics Symposium.** Institution of Electrical Engineers. (The Measurement & Control Section, The Institution of Electrical Engineers, Savoy Place, London, W.C.2.)

Dec. 6th. **New Electronic Techniques in Non-destructive Testing.** Wolverhampton and Staffordshire College of Technology. (Hon. Sec. West Midlands Section, British Institution of Radio Engineers, 5, Shelton Fields, The Mount, Shrewsbury.)

Jan. 8th–12th, 1962. **Conference on International Developments in Heat Transfer.** The Lecture Hall, Central Hall, Westminster, London, S.W.1. (The Institution of Mechanical Engineers, 1, Birdcage Walk, London, S.W.1.)

Jan. 9th–11th, 1962. **Eighth National Symposium on Reliability and Quality Control.** Statler Hilton Hotel, Washington, D.C.

Jan. 15th–19th, 1962. **Physical Society Exhibition of Scientific Instruments and Apparatus.** Old and New Horticultural Halls, London. (The Physical Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7.)

Jan. 17th–18th, 1962. **Symposium on Electronic Aids to Banking.** I.E.E., Savoy Place, London, W.C.2.

Feb. 16th–20th, 1962. **International Radio and Electronic Components Exhibition.** Paris, France. (Federation Nationale des Industries Electroniques, 23, rue de Lubeck, Paris, 16.)

Feb. 26th–28th, 1962. **Conference on the Importance of Electricity in the Control of Aircraft.** (The Institution of Electrical Engineers, Savoy Place, London, W.C.2.)

March 13th–15th, 1962. **Conference on Testing for Performance.** The Plastics Institute, London.

March 20th–24th, 1962. **Electrical Engineers (A.S.E.E.) Exhibition.** Earls Court, London. (Electrical Engineers (A.S.E.E.) Exhibitions Ltd., 6 Museum House, 25, Museum Street, London, W.C.1.)

March 26th–29th, 1962. **I.E.R. International Convention.** New York. (Institute of Radio Engineers, 1, East 79th Street, New York, 21.)

April 9th–13th, 1962. **International Pipes, Pipelines, Pumps and Valves Exhibition and Conference.** Earls Court, London. (Scientific Surveys Ltd., 97, Old Brompton Road, London, S.W.7.)

April 10th–14th, 1962. **Second International Conference on Stress Analysis.** Paris.

April 13th–19th. **International Refrigeration Fair.** Grand Hall, Olympia. (International Refrigeration Fair, 2, Dunraven Street, London, W.1.)

April 25th–May 4th, 1962. **International Congress and Exhibition of Laboratory Measurement and Automation Techniques in Chemistry.** Basle.

April 30th–May 4th, 1962. **International Compressed Air and Hydraulics Exhibition and Conference.** Olympia, London. (Commercial Exhibitions Ltd., St. Richards House, Eversholt Street, London, N.W.1.)

May 2nd–11th, 1962. **Power Generation and Clean Air Equipment Exhibition.** Olympia. (Engineering in Britain, 34, Victoria Street, London, S.W.1.)

May 2nd–11th, 1962. **Space Research & Technology.** (Sponsored by the British Interplanetary Society), Olympia. (Engineering in Britain, 34, Victoria Street, London, S.W.1.)

May 3rd.–5th, 1962. **International Conference of University Computing Centre.** Mexico City. (Centro Electronico de Calculo, Universidad Nacional Autonoma de Mexico, Mexico D.F.).

May 8th–18th, 1962. **Mechanical Handling Exhibition.** Earls Court, London. (Iliffe Exhibitions Ltd., Dorset House, Stamford Street, London, S.E.1.)

May 18th–June 3rd, 1962. **British Trade Fair.** Stockholm.

May 28th–June 2nd, 1962. **Instruments, Electronics and Automation International Exhibition.** Olympia, London. (Industrial Exhibitions Ltd., 9, Argyll Street, London, W.1.)

June 20th–30th, 1962. **2nd Chemical & Petroleum Engineering Exhibition.** Olympia. (Engineering in Britain, 34, Victoria Street, London, S.W.1.)

June 25th–28th, 1962. **4th Congress of the Federation of European Petroleum Equipment Manufacturers.** Church Hall, Westminster. (Engineering in Britain, 34, Victoria Street, London, S.W.1.)

July 23rd–28th, 1962. **Engineering Exhibition.** Sydney, Australia. (Industrial Public Relations Services of Australia, Box 4962, G.P.O. Sydney, N.S.W.)

Aug. 5th–11th, 1962. **Second International Congress of Radiation Research.** England.

Aug. 23rd–Sept. 2nd. 1962. **Sixth International Fair of Technics and Technical Achievements.** Belgrade.

Aug. 27th–Sept. 1st, 1962. **IFIP Congress 62.** Munich. (International Federation of Information Processing Societies).

Aug. 29th–Sept. 5th, 1962. **Fifth International Congress of Electron Microscopy.** Philadelphia.

Sept. 3rd–8th, 1962. **1st International Congress on Chemical Machinery, Chemical Engineering and Automation.** Brno, Czechoslovakia. (Organising Committee for the 1st International Congress on Chemical Engineering and Automation, Výstaviště 1, Brno, Czechoslovakia.)

Oct. 15th–18th, 1962. **Materials Handling Exhibition.** Toronto, Canada. (Materials Handling in Canadian Industry, 481, University Avenue, Toronto.)

Oct. 15th–19th, 1962. **Instrument-Automation Conference and Exhibition.** New York, U.S.A. (Instrument Society of America, 313, Sixth Avenue, Pittsburgh 22, Pa.)

Oct. 15th–20th, 1962. **Laboratory, Measurement and Automation Techniques in Chemistry Exhibition.** Basle, Switzerland. (Sekretariat, Schweizer Mustermesse, Basle, 21.)

Nov. 27th–30th, 1962. **Fourth Corrosion and Metal Finishing Exhibition.** Olympia, London.

(*Continued from page* 1466.)

Thermocouples

The Cambridge Instrument Co. Ltd. has issued a new publication, List 325, describing their standard range of rare and base metal thermocouples for temperatures up to 1,500°C.

The publication gives details of the factors governing the choice of suitable assemblies for widely differing applications, and describes a simple three-letter coding system which simplifies the ordering of stock assemblies and replacement parts.

Circle **101** *for further details.*

Components Brochure

The Plessey Co. Ltd. has made available an illustrated brochure giving details of scanning components in current production for use in conjunction with 110° and 114° long and short neck television tubes.

The brochure illustrates and describes deflection coil units, line and frame output transformers and line and frame blocking oscillator transformers, giving full details of the components' electrical characteristics and physical dimensions.

Circle **102** *for further details.*

"Instrumentation"

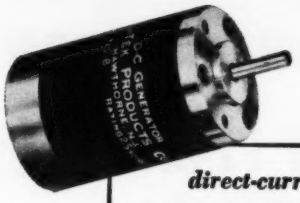
Vol. 14, No. 2, of *Instrumentation*, published by Minneapolis Honeywell Regulator Co., includes a number of articles on a wide range of subjects. Those of particular interest to our readers are mentioned below:

"Torture Test makes Tyres Safer" deals with an instrumentation system at multi-stage dynamometer laboratory of Goodyear Tyre & Rubber Co. which evaluates tyre design and performance. "Simple Telemetering goes Modern", introducing the Dur-O-Pulse system and "Moisture Control for Industry".

Instrumentation is available in this country from Honeywell Controls Ltd.

Circle **103** *for further details.*

Circle 371 for further information



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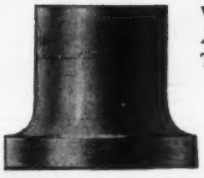

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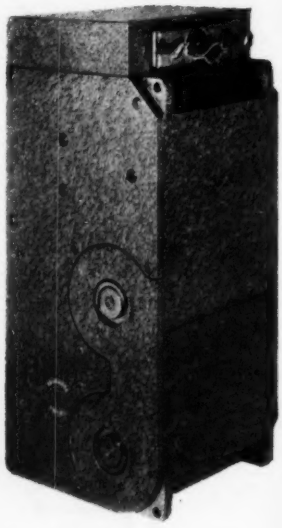

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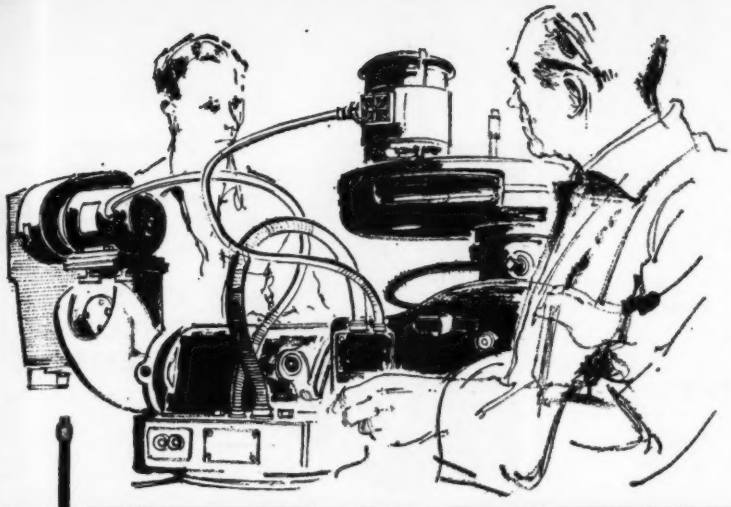

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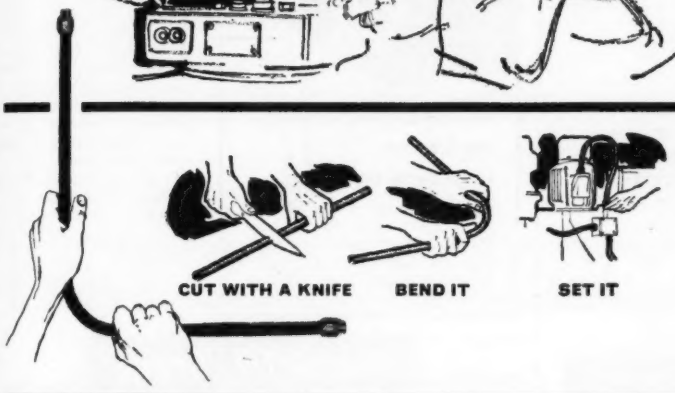

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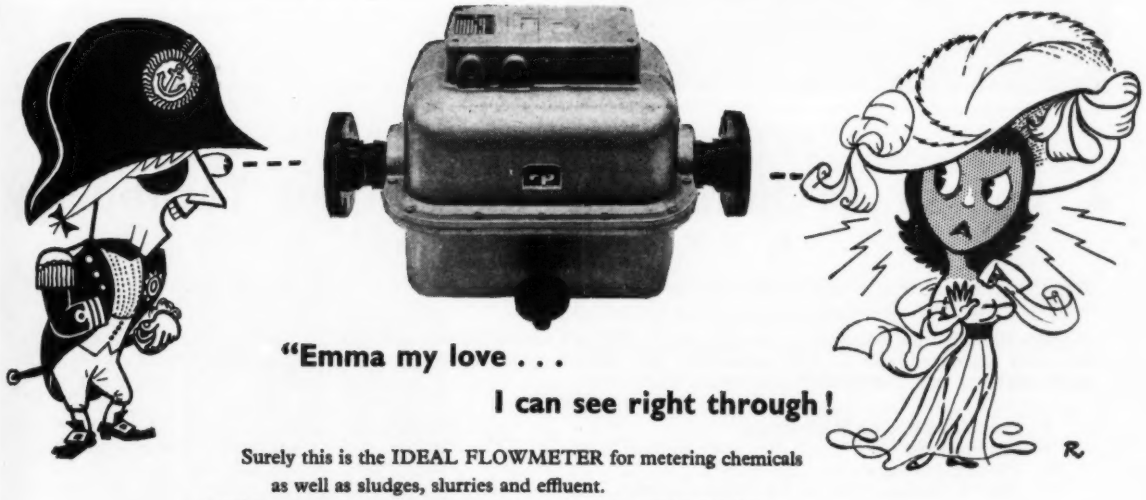

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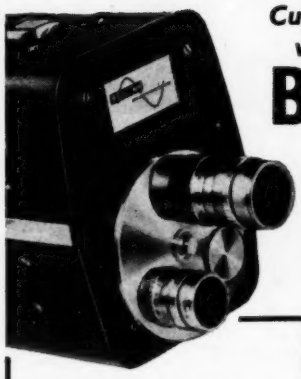

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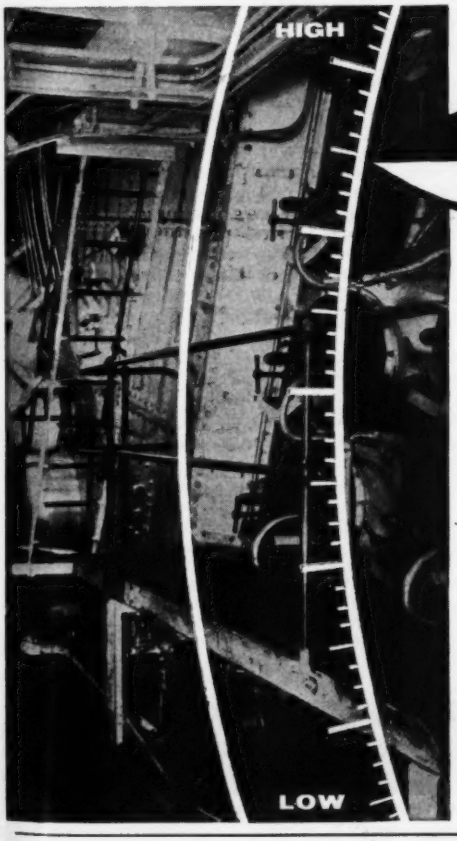

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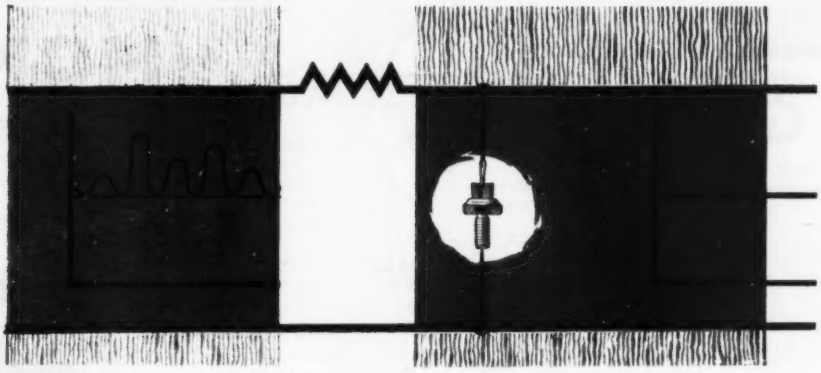

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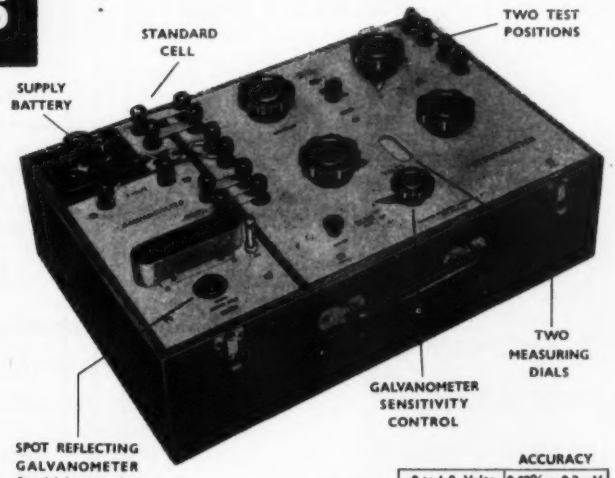

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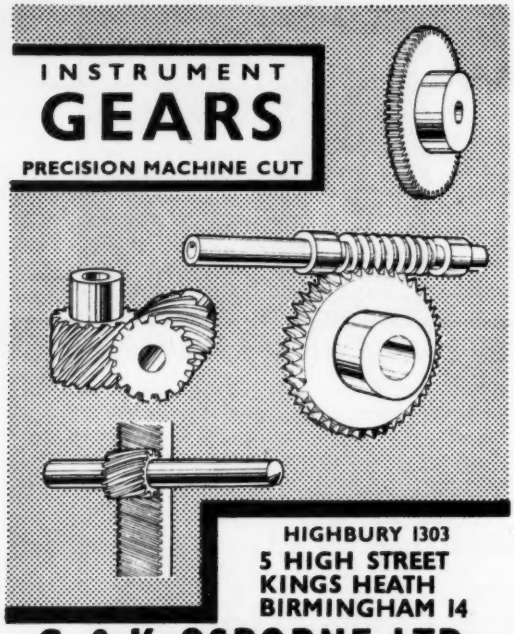

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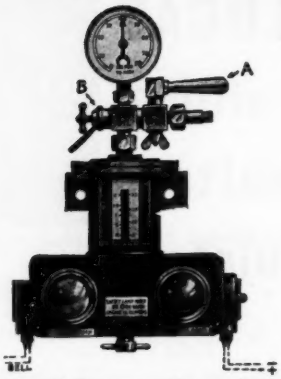

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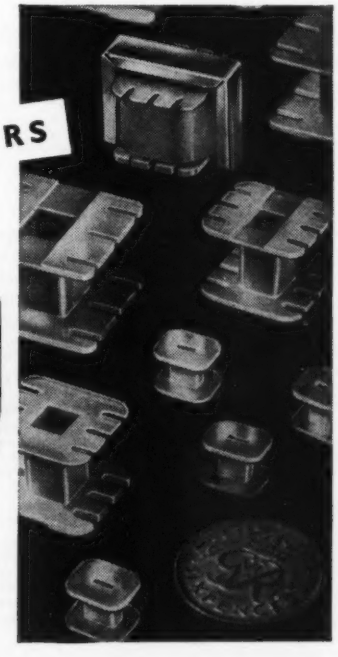

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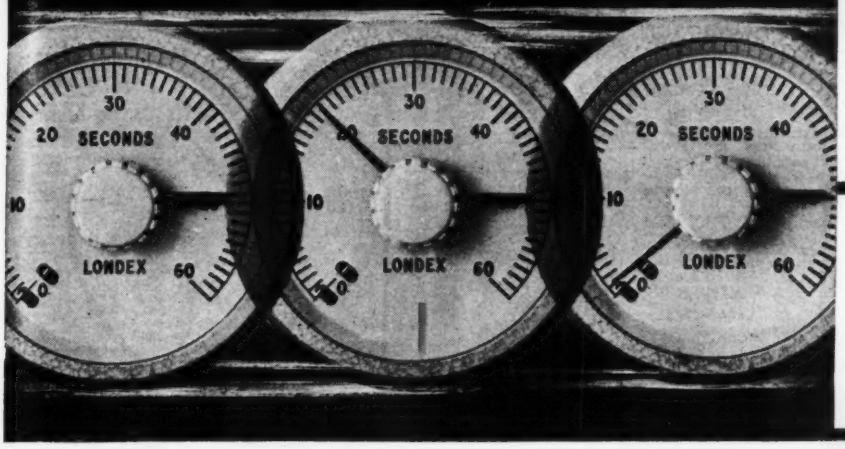

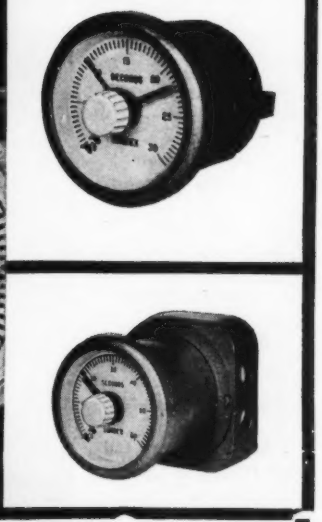

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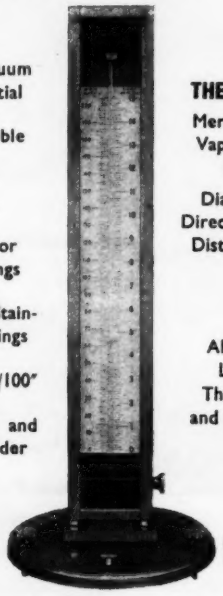

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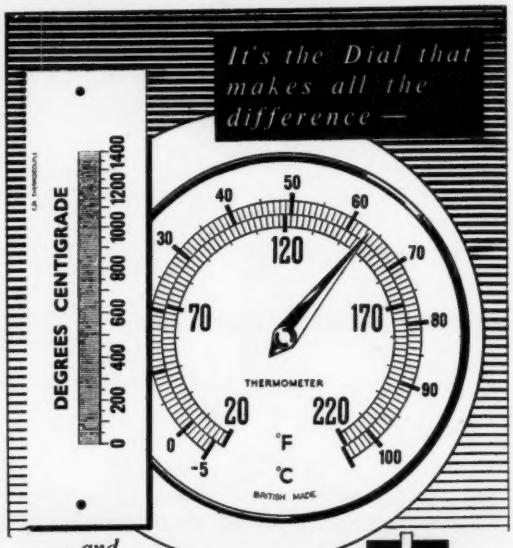

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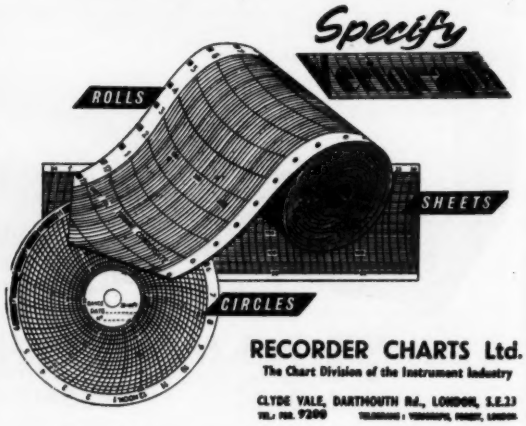

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INDEX TO ADVERTISERS

	Page
Advance Components Ltd.	1339, 1363
A.E.I.-Birlec Ltd.	1465
Airflow Developments Ltd.	1481
Alexander Controls Ltd.	1362
Alto Instruments (Great Britain) Ltd.	1374
Arrow Electric Switches Ltd.	1458
Associated Electrical Industries Ltd.	1356-1357
Avo Ltd.	October
Bailey Meters and Controls Ltd.	October
Baldwin Instrument Co. Ltd.	1350
Bamford & Co. Ltd., F.	1467
Barrow Hepburn & Gale Ltd.	October
Bedford, A. H. & Son Ltd.	1470
Bellows-Valvair Ltd.	1463
B.E.N. Patents Ltd.	1470
Blackburn Electronics Ltd.	1359
Blakeborough & Sons Ltd., J.	October
Bradley Ltd., G. & E.	1475
Brooks Instrument Ltd.	1340-1341
British Arca Regulators Ltd.	1368
British Driver-Harris Co. Ltd.	October
British Rototherm Co. Ltd., The	1370
British Sonceboz Co. Ltd., The	Inside Front Cover
Buck & Hickman Ltd.	October
Budenberg Gauge Co. Ltd.	October
Burndept Ltd.	1369
Cambridge Instrument Co. Ltd.	1465
Classified Advertisements	1478, 1479, 1480
Cobb-Slater Instrument Co. Ltd., The	October
Cockburns Ltd.	October
Cooke & Sons Ltd., James	1482
Coulter Electronics Ltd.	October
Counting Instruments Ltd.	October
Crosby Valve & Engineering Co. Ltd.	1354
Croydon Precision Instrument Company	1475
Dallmeyer Ltd., J. H.	1480
Datum Metal Products Ltd.	1348
Davy & United Instruments Ltd.	October
Dawe Instruments Ltd.	1358
Dewrance & Co. Ltd.	October
Dobbie McInnes (Electronics) Ltd.	1374
Drayton Controls Ltd.	1447
D.T.V. Group, The	1472
E. & H. Filter Co. Ltd., The	1482
Ekco Electronics Ltd.	1417
Electrical Development Association	1429
Electro Methods Ltd.	1336
Electronic Engineering Association, The	1474
Ellay Tubes Ltd.	1463
Elliott Brothers (London) Ltd.	1345
Elliott Brothers Sales Agencies Ltd.	October
Engelhard Industries Ltd.	1346
English Electric Co. Ltd., The	1333
English Numbering Machines Ltd.	1360
Ether Ltd.	1347, 1353, 1460
Evans Electroselenium Ltd.	1457
Fafnir Bearing Co. Ltd.	1366
Fielden Electronics Ltd.	1337, 1365
Filhol Ltd., J. P.	1472
Formica Ltd.	1373
Firth Cleveland Instruments Ltd.	October
Fischer & Porter Ltd.	1471
Foxboro-Yoxall Ltd.	Inside Back Cover
General Electric Co. Ltd. of England, The	1378
Gilbarco Ltd.	1477
Goodman Ltd., George	1477
Goodmans Industries Ltd.	1344
Gordon & Co. Ltd., James	1473
Herbert Ltd., Alfred	1371
Hoffmann Mfg. Co. Ltd., The	1334
Hone & Co. Ltd., F. J.	1364
Honeywell Controls Ltd.	Back Cover
Hughes International (U.K.) Ltd.	1355
Imhof Ltd., Alfred	1432

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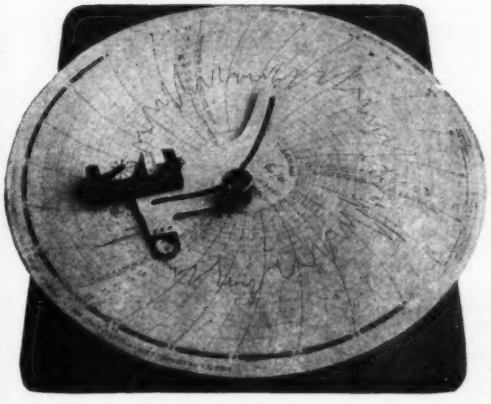

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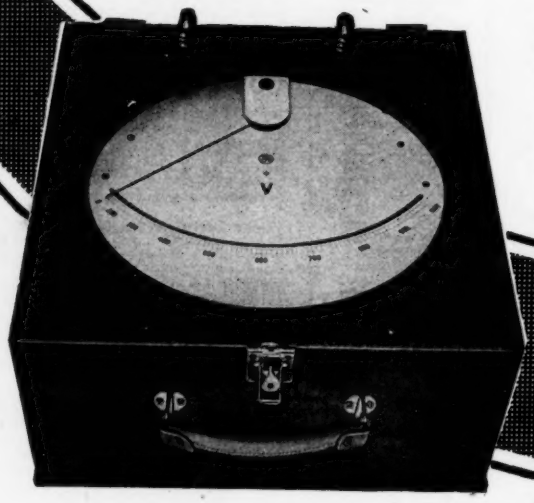

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INDEX TO ADVERTISERS *(continued)*

	Page
Johnson Matthey & Co. Ltd.	1375
K.D.G. Instruments Ltd.	October
Kent Ltd., George	1380
Langham Thompson Ltd., J.	1376
Lang Pneumatic Ltd.	October
Leeds & Northrup Ltd.	1418
Lindsey, C. S. Ltd.	1480
Londex Ltd.	1481
Lucas Ltd., Joseph	1475
McMurdo Instrument Co. Ltd., The	October
Metway Products	1480
Midland Silicones Ltd.	1454
Miniature Bearings Co. Ltd.	October
Modern Plastics Ltd.	1476
"Monitor" Patent Safety Devices Ltd.	1476
Morris (Clerkenwell) Ltd., John	1478
Murex Ltd.	1372
Nalder Bros. & Thompson Ltd.	1484
Negretti & Zambra Ltd.	October
Newall Group Sales Ltd.	1343
New Western (Engineering) Ltd.	October
Norgren, C. A. Ltd.	October
NSF Ltd.	October
Osborne Ltd., G. & K.	1476
Parmeko Ltd.	October
Payne & Griffiths Ltd.	1473
Permutit Co. Ltd., The	1467
Pilot Plug Gauge Co. Ltd., The	October
Preformations Ltd.	October
Premier Screw & Repetition Co. Ltd.	1338
Purdie, E. J. & Son Ltd.	1478
Pyrotenax Ltd.	1351
Racal Instruments Ltd.	1349
RCA Great Britain Ltd.	October
Recorder Charts Ltd.	1482
Research & Control Instruments Ltd.	1367
Rotameter Manufacturing Co. Ltd.	1448
Rundle, A. (Upper Norwood) Ltd.	1478
Salford Electrical Instruments Ltd.	1372
Sanders (Electronics) Ltd., W. H.	1335
Sangamo Weston Ltd.	1366
Savage Transformers Ltd.	1342
Servomex Controls Ltd.	October
Servo-Tek Products Co.	1469
S. E. Laboratories (Engineering) Ltd.	1452
Sifam Electrical Instruments Co. Ltd.	1352
Sigma Instruments Co. Ltd.	1467
Simplifix Couplings Ltd.	October
Smiths Aviation Division	October
Smiths Industrial Division	1437
Spencer Components	October
Stanley, W. F. & Co. Ltd.	1483
Stephens Ltd., Henry C.	1480
Taylor Controls Ltd.	Front Cover
Telcon Metals Ltd.	1370
Teledictor Ltd.	1368
Telephone Manufacturing Co. Ltd.	1361
Tinsley & Co. Ltd., H.	October
Turner, Ernest, Electrical Instruments Ltd.	October
Unicam Instruments Ltd.	October
United Trade Press Ltd.	1472
Uni-Tubes Ltd.	1471
Wade Couplings Ltd.	1469
Walker, Crosweller & Co. Ltd.	1442
Wallace & Tiernan Ltd.	1364
Westool Ltd.	October
Whilems Ltd., C. J.	October
Woodhill Engineering Co. Ltd.	1470
Zeal Ltd., G. H.	1482

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lines)
BMJ

Page
1482
1367
1448
1478

1372
1335
1366
1342
October
1469
1452
1352
1467
October
October
1437
October
1483
1480

Cover
1370
1368
1361
October
October

ctober
1472
1471

1469
1442
1364
ctober
ctober
1470

1482